TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE.

Volume XXX

Fifty-first Annual Meeting, Manhattan,
April 18-19, 1919

Fifty-second Annual Meeting, Pittsburg,
April 23-24, 1920

Fitty-third Annual Meeting, Lawrence,
February 18-19, 1921

PRINTED BY KANSAS STATE PRINTING PLANT
B P. WALKER, STATE PRINTER
TOPEKA 1922
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PART I.

CONSTITUTION OF THE ACADEMY.

SECTION 1. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in the various departments of science

SEC. 3. The members of this Academy shall consist of two general classes—honorary and active.

(1) *Active members* shall be classified as local members and national members Local members shall be those who are members of this Academy only. Local members may be elected at any time by the committee on membership, which shall consist of the secretary and two other members appointed by the president, annually. Annual members shall pay a fee of one dollar and annual dues of one dollar; but the secretary and treasurer shall be exempt from the payment of dues during the years of their service Any person who shall at one time contribute $20 to the funds of this Academy may be elected a *life member* of the Academy, free of assessment Any member who has paid dues to the Academy for ten consecutive years, or who has been legally exempt during any portion of that time, may be elected a *life member* on the payment of $10 Any member who has been a member of this Academy in good standing for twenty years may be elected a *life member* without payment of further fees or dues *Honorary members* may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case, a two-thirds vote of members present shall elect to honorary or life membership.

(2) *National members* shall consist of those who are also members of the American Association for the Advancement of Science.

Each national member, except life members of the Academy, shall pay or shall have paid an initiation fee of one dollar to this Academy, and shall pay an annual fee equal to the annual fee assessed by the American Association for the Advancement of Science. The Academy shall be entitled to one dollar annually as its share of the above fee. Life members of the Academy shall pay the assessment of the American Association for the Advancement of Science less one dollar, and all of this shall be sent to the American association.

The classification of members, together with the fees to be paid, is as follows:

1. Honorary. No dues.
2. Active.
   (1) Local.
      (a) Annual. Dues, $1 per year.
      (b) Life. No dues.

(2) National.

(a) Local life, national annual. Dues, $1 less than the assessment of the A. A. A. S.

(b) Local life, national life. No dues.

(c) Local annual, national annual. Dues, an amount equal to the assessment of the A. A. A. S, one dollar of which the Academy shall keep.

(d) Local annual, national life. Dues, $1 per year.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, two vice presidents, a secretary and a treasurer, who shall perform the duties usually pertaining to their respective offices The president, the secretary and the treasurer shall constitute the executive committee. The secretary shall have charge of all the books, collections and material property belonging to the Academy

SEC 5 Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the executive committee shall designate. Other meetings may be called at the discretion of the executive committee.

SEC. 6 This constitution may be altered or amended at any annual meeting by a vote of three-fourths of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

SEC. 7. This Academy shall have an executive council, consisting of the president, the secretary, the treasurer, the vice presidents, and four other members to be nominated by the nominating committee and elected as the other officers. This council shall have general oversight of the Academy not otherwise given by this constitution to officers or committees.

BY-LAWS.

I. The first hour, or such part thereof as shall be necessary, in each session, shall be set aside for the transaction of the business of the Academy The following order of business shall be observed, so far as practicable

1. Opening.
2. Reports of officers.
3. Reports of standing committees
4. Appointment of special committees
5. Unfinished business.
6. New business.
7. Reports of special committees.
8. Election of officers.
9. Election of members.
10. Program.
11. Adjournment.

II. The president shall deliver a public address on the evening of one of the days of the meeting, at the expiration of his term of office.

III. No meeting of this Academy shall be held without a notice of the same having been published in the papers of the state at least thirty days previous.

IV. No bill against the Academy shall be paid by the treasurer without an order signed by the president and secretary.

V. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the treasurer, shall have their names stricken from the roll.

VI. The secretary shall have charge of the distribution, sale and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the executive committee.

VII. Eight members shall constitute a quorum for the transaction of business.

VIII. The time allotted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

PAST PRESIDENTS.

1869, 1870	B F Mudge.	1899	E B. Knerr.
1871–1873	John Fraser	1900	A S Hitchcock.
1874–1878	F. H Snow.	1901	E Miller
1879, 1880	B. F Mudge.	1902	J T. Willard.
1881, 1882	J T. Lovewell	1903	J. C Cooper.
1883	A H Thompson	1904	Edward Bartow.
1884, 1885	R J Brown	1905	L. C Wooster.
1886	E L Nichols	1906	F. O. Marvin.
1887	J. D Parker	1907	J A Yates
1888	J R Mead	1908	E. Haworth
1889	T H Dinsmore, jr.	1909, 1910	F B. Dains.
1890	G H. Failyer	1911	J. M. McWharf.
1891	Robert Hay.	1912	F. W. Bushong
1892	E. A. Popenoe.	1913	A. J Smith
1893	E. H. S Bailey.	1914	W. A. Harshbarger
1894	L. E. Sayre.	1915	J. A. G. Shirk.
1895	Warren Knaus.	1916	J. E. Todd.
1896	D. S. Kelley.	1917	F. U G Agrelius.
1897	S. W. Williston.	1918	L. D. Havenhill.
1898	D. E. Lantz.		

OFFICERS OF THE ACADEMY, 1919.

President, L. D. Havenhill.................................. Lawrence.
First Vice President, R. K. Nabours......................... Manhattan.
Second Vice President, B. M. Allen.......................... Lawrence.
Treasurer, Acting, L. D. Havenhill........................... Lawrence.
Secretary, E. A. White....................................... Lawrence.

EXECUTIVE COUNCIL.

A. J. Smith .... Emporia.
J. A. G. Shirk .... Pittsburg.
Dr. J. M. McWharf .... Ottawa.

OFFICERS OF THE ACADEMY, 1920.

President, R. K. Nabours .... Manhattan.
First Vice President, Bennett M. Allen .... Lawrence.
Second Vice President, O. P. Dellinger .... Pittsburg.
Treasurer, L. D Havenhill .... Lawrence.
Secretary, E. A. White .... Lawrence.

EXECUTIVE COUNCIL.

Warren Knaus .... McPherson
W. A. Harshbarger .... Topeka.
LeRoy Hughbanks .... Anthony.

OFFICERS OF THE ACADEMY, 1921.

President, O. P. Dellinger .... Pittsburg.
First Vice President, Roy Rankin .... Hays.
Second Vice President, W. P. Hays .... Manhattan
Treasurer, L. D. Havenhill .... Lawrence.
Secretary, E. A. White .... Lawrence.

EXECUTIVE COUNCIL.

J. T. Willard .... Manhattan.
W. J. Baumgartner .... Lawrence.
W. A. Harshbarger .... Topeka.
Frank U. G. Agrelius .... Emporia.

MEMBERSHIP OF THE ACADEMY,

January 1, 1921.

Dates signify date of election in the Academy.

HONORARY MEMBERS.

Marshall A Barber, Ph D , 1904
T. D. A Cockerell, Ph. D , 1918, 908 Tenth street, Boulder, Colo.
W. S. Franklin, Sc. D , 1897, Cambridge, Mass
G P. Grimsley, Ph D , 1896, Thirty-first and Calvert streets, Baltimore, Md.
A S. Hitchcock, M S., 1892, U. S. Department of Agriculture, Washington, D. C
J Arthur Harris, Ph D , 1900, Carnegie Institution, Cold Spring Harbor, Long Island, N. Y
Vernon L. Kellogg, M. S , Leland Stanford, Jr , University, California.
C E McClung, 1903, National Research Council, Washington, D. C.
E V McCollum, Ph. D., 1902, Johns Hopkins University, Baltimore, Md
E L Nichols, Ph D , 1897, Cornell University, Ithaca, N Y.
Elmer S Riggs, A M , Field Museum, Chicago, Ill
George Wagner, Ph. C , 1904, Madison, Wis

LIFE MEMBERS.

E H. S. Bailey, Ph. D , 1883, professor of chemistry, University of Kansas, Lawrence, Kan
Elam Bartholomew, M C., 1896, mycologist, Stockton
Edward Bartow, Ph D , 1897, State University of Iowa, Iowa City, Iowa.
Joshua W Beede, Ph. D , 1894, professor of geology, University of Texas, Austin, Tex.
F W Bushong, Sc D , 1896, Gulf Refining Company, 2636 Fifth avenue, Port Arthur, Tex.
Rev John T Copley, 1903, Olathe, Kan
F. W Cragin, Ph D., 1880, 912 Miguel street, Colorado Springs, Colo
F F. Crevecoeur, 1900, Onaga, Kan
Frank B Dains, Ph D , 1902, professor of chemistry, University of Kansas, Lawrence, Kan.
R B Dunlevy, M A , 1896, Southwestern College, Winfield, Kan
T. L Eyerly, 1906, Dallas, Tex.
George H Failyer, M Sc , 1879, R F. D. 4, Manhattan, Kan.
A O Garrett, 1901, professor of botany, high school, Salt Lake City, Utah.
Edward Curtis Franklin, Ph. D , 1884, professor of chemistry, Leland Stanford, Jr., University, California.
I D. Graham, 1879, State Board of Agriculture, Topeka, Kan.
Henry Jacob Harnly, Ph. D., 1893, professor of biology, McPherson College, McPherson, Kan.
William Asbury Harshbarger, B Sc , 1903, professor of mathematics, Washburn College, Topeka, Kan.
Erasmus Haworth, Ph D., 1882.
A. W. Jones, B. Sc , 1894, farmer, Sandpoint, Idaho
W. H. Keller, A. B , 1898, professor of mathematics, Kansas State Normal School, Emporia, Kan.
J. M. McWharf, M. D., 1902, Ottawa, Kan.
Warren Knaus, M. Sc., editor and entomologist, McPherson, Kan.
Grace R. Meeker, A. B., 1899, city librarian, Ottawa, Kan.
C. F. Menninger, M. D., 1903, Topeka, Kan.
Ephriam Miller, Ph. D., 1873, 558 North Lake avenue, Pasadena, Cal.
A. M. Nissen, A. M., 1888, farmer, Wetmore, Kan.
Albert B. Reagan, 1904, principal Marsh Pass Indian School, Kayenta, Ariz.
Lucius E. Sayre, B. Sc., Ph. M., 1885, dean School of Pharmacy, University of Kansas, Lawrence, Kan.
Edwin Taylor Shelly, M. D., 1892, Atchison, Kan.
Alva J. Smith, 1893, city engineer, Emporia, Kan.
E. G. Smyth, 1901, entomologist, Santa Rica, P. R.
Mrs. Lumina C. Riddle Smyth, Ph. D., 1902, Munden, Kan.
Charles H. Sternberg, 1896, vertebrate paleontologist, Balboa Park, Cal.

Nilan L. Ward, D D, 1880, emeritus professor of mathematics, Ottawa University, Ottawa, Kan.

Julius T Willard, Sc D, 1883, vice president Kansas State Agricultural College, Manhattan, Kan.

Lyman C Wooster, Ph. D, 1889, professor of zoology and geology, Kansas State Normal School, Emporia, Kan

John E Welin, Sc D, 1889, professor of chemistry and physics, Bethany College, Lindsborg, Kan

James A Yates, M Sc, 1898, professor of chemical and physical sciences, Kansas State Manual Training Normal School, Pittsburg, Kan

ANNUAL MEMBERS

James E Ackert, Ph D, 1917, associate professor of zoology, Kansas State Agricultural College, Manhattan, Kan

Frank U. G Agrelius, A M, 1905, associate professor of bacteriology and botany, Kansas State Normal School, Emporia, Kan

Florence M Alsop, A B, 1918, assistant in zoology, Kansas State Agricultural College, Manhattan, Kan

Herman C Allen, Ph D, 1904, professor of chemistry, University of Kansas, Lawrence, Kan

Bennett M Allen, Ph D, 1913, professor of zoology, University of Kansas, Lawrence, Kan

Forrest N Anderson, A M, 1918, medical student, Lawrence, Kan

Jane K Atwood, M Sc, department of geography, Kansas State Normal School, Emporia, Kan.

W E Barker, M D, 1916, Chanute, Kan

W V Bass, A B, 1917, instructor in physical sciences, State Manual Training Normal School, Pittsburg, Kan

W. J. Baumgartner, A M, 1904, associate professor of zoology, University of Kansas, Lawrence, Kan

F G Bedell, 1904, Dodge City, Kan

L. Jean Bogert, 1921, teacher of domestic science, Kansas State Agricultural College, Manhattan, Kan

H H Braucher, B Sc, 1907, professor of manual training, Kansas State Normal School, Emporia, Kan

Elizabeth Brown, teacher, 1919, Marysville, Kan

Ray J Brewster, 1919, assistant professor of chemistry, University of Kansas, Lawrence, Kan

Alice Lenore Brown, A B., instructor in zoology, Kansas State Agricultural College, Manhattan, Kan

Charles H Brooks, 1919, superintendent of schools, Stockton, Kan

H. W. Brubaker, 1919, associate professor of Chemistry, Kansas State Agricultural College, Manhattan, Kan

Ernest F Buram, 1916, Pittsburg, Kan

Robert D. Bussy, 1917, Centralia, Kan

Leland D Bushnell, 1908, M Sc, professor of bacteriology, Kansas State Agricultural College, Manhattan, Kan

H P Cady, Ph. D., professor of chemistry, University of Kansas, Lawrence, Kan.

M E Canty, 1903, Fredonia, Kan

Vaughn B. Caris, A. M., 1911, assistant professor of mathematics, Kansas State Manual Training Normal School, Pittsburg, Kan.

Grace M. Charles, Ph. D., 1918, department of botany, University of Kansas, Lawrence, Kan

George E Coghill, Ph. D, 1918, professor of anatomy, University of Kansas, Lawrence, Kan.

W. E. Connelley, 1916, secretary State Historical Society, Topeka, Kan.

W A. Cook, M. Sc, 1907, Garrison, Kan

Robert A. Cooley, B Sc., 1910, professor of zoology and entomology, Montana State College, Bozeman, Mont.

Margaret Coventry, A. B., 1914, instructor in physical sciences, Kansas State Manual Training Normal School, Pittsburg, Kan.

W. M. Crotinger, A. B., 1916, farmer, Bison, Kan

Arthur J. Culler, B. D., Ph. D., 1917, professor of theology and English, McPherson College, McPherson, Kan.

Bertha L. Danheim, 1919, teacher, Blue Rapids, Kan.

George A. Dean, M. Sc., 1903, professor of entomology, Kansas State Agricultural College, Manhattan, Kan.

Frank L. DeBeukelaer, A. M., 1916, professor of chemistry, University of Chicago, Chicago, Ill.

Howard de Forest, Ph. D., 1921, director of science department, Indianapolis Normal School, Indianapolis, Ind.

Emil O. Deere, A. M, 1905, professor of biology and geology, Bethany College, Lindsborg, Kan

Samuel A Deel, Ph B, 1913, professor of physics, Baker University, Baldwin, Kan.

Oris P. Dellinger, Ph. D., 1909, professor of biology, Kansas State Manual Training Normal School, Pittsburg, Kan.

R E. Devore, A B., 1916, teacher, Muscotah, Kan

A T Dunham, 1920, miner, Pittsburg, Kan

J Whit Eby, 1903, banker, Howard, Kan

W L Eikenberry, 1919, assistant professor of education, University of Kansas, Lawrence, Kan

H M Elsey, Ph. D, 1919, assistant professor of chemistry, University of Kansas, Lawrence, Kan

George V. Emery, 1920, teacher of physics, State Manual Training Normal School, Pittsburg, Kan

Herman C Erickson, 1921, state superintendent free employment bureau, Topeka, Kan.

Henry L. Fackler, 1918, assistant state entomologist, Knoxville, Tenn.

P L Gainey, 1919, professor of bacteriology, Kansas State Agricultural College, Manhattan, Kan

A A Graham, 1910, attorney, Topeka, Kan

Myrtle Greenfield, 1918, bacteriologist, Lawrence, Kan

Richard L Grider, E M, 1918, assistant professor of mining, University of Kansas, Lawrence, Kan

L D Haverhill, B Sc, Ph C, 1904, professor of pharmacy, University of Kansas, Lawrence, Kan

J O Hamilton, 1919, professor of physics, Kansas State Agricultural College, Manhattan, Kan

Louis Hay, 1921, teacher of physics, Augusta high school, Augusta, Kan

J Newton Harrison, 1916, farmer, Topeka, Kan

Mary T Harman, Ph D, 1912, assistant professor of zoology, Kansas State Agricultural College, Manhattan, Kan

Wm P Hayes, 1919, assistant professor of entomology, Kansas State Agricultural College, Manhattan, Kan.

A W Hayne, 1918, oculist, Lawrence, Kan

J Willard Hershey, professor of chemistry, McPherson College, McPherson, Kan.

Amos H. Hersh, A M, 1918, instructor in zoology, Kansas State Agricultural College, Manhattan, Kan

Frederick L Hisaw, B. S, A M, 1921, assistant professor of zoology, Kansas State Agricultural College, Manhattan, Kan

Rudolph Hirsch, 1918, chemist, Ridenour-Baker Grocery Company, Kansas City, Mo.

William E. Hoffman, 1920, assistant curator museum, University of Kansas, Lawrence, Kan.

Leroy Hughbanks, 1914, minister, lecturer, Anthony, Kan.

I. W. Humphrey, M. Sc, 1912, Dover, N. J.

H. B Hungerford, Ph. D, 1920, associate professor of entomology, University of Kansas, Lawrence, Kan.

W. S. Hunter, Ph. D., 1919, professor of psychology, University of Kansas, Lawrence, Kan.

W. M. Jardine, LL. D, 1919, president Kansas State Agricultural College, Manhattan, Kan.

T. B. Jennings, 1917, director U. S. Weather Bureau, Topeka, Kan.

Ed C. Jerman, 1911, electrician, Topeka, Kan.

Charles E. Johnson, 1921, associate professor of zoölogy, University of Kansas, Lawrence, Kan.

E. G. Kelly, 1921, entomologist, Kansas State Agricultural College, Manhattan, Kan.

F. J. Kelly, Ph. D., 1919, dean of administration, Kansas University, Lawrence, Kan.

Harry L. Kent, B. Sc., 1904, principal School of Agriculture, Kansas State Agricultural College, Manhattan, Kan.

John H. Klopfer, 1904, Topeka, Kan.

Herbert Hiram King, M. Sc., 1909, associate professor of chemistry, Kansas State Agricultural College, Manhattan, Kan.

ANNUAL MEMBERS.

P. E. Laird, A. B., B. S., 1918, teacher of chemistry, State Normal School, Durant, Okla.
H. R. Laing, 1921, teacher of chemistry, Augusta high school, Augusta, Kan.
P. B. Lawson, Ph. D., 1919, professor of entomology, University of Kansas, Lawrence, Kan.
William A. Lewis, LL D , 1918, president Fort Hays Kansas Normal School, Hays, Kan.
Marcus A. Low, 1906, attorney Chicago, Rock Island & Pacific Railway, Topeka, Kan
Walter S. Long, A. M , 1913, assistant professor of chemistry, University of Kansas, Lawrence, Kan.
F. A. Marlatt, 1920, manufacturer, Manhattan, Kan.
W. H. Matthews, 1920, teacher of physics, State Manual Training Normal School, Pittsburg, Kan.
Robley D. E Matthews, miner, Pittsburg, Kan
Bess J. McKittrick, 1919, teacher, Kansas State Agricultural College, Manhattan, Kan
James W. McColloch, 1919, teacher, Kansas Experiment Station, Manhattan, Kan
James B. McNaught, 1919, bacteriologist, University of Kansas, Lawrence, Kan.
Karl A. Menninger, M D , 1919, Topeka, Kan
L. E. Melchers, M S , 1918, associate professor of botany, Kansas State Agricultural College, Manhattan, Kan.
Ella Weeks Menoher, 1903, Manhattan, Kan
J. H. Merrill, Ph D , 1919, state apiarist, Manhattan, Kan.
Clarence A. Mills, A B , 1918, teacher, Medical College, Cincinnati, Ohio.
S. T. Millard, M. D., 1909, Topeka, Kan.
A. J. Mix, Ph D , 1918, professor of botany, University of Kansas, Lawrence, Kan
E. C. Miller, Ph D , 1918, assistant professor of botany, Kansas State Agricultural College, Manhattan, Kan
Raymond C. Moore, Ph D , 1918, assistant professor of geology, state geologist, University of Kansas, Lawrence, Kan
R. L. Moodie, Ph D , 1908, assistant professor of anatomy, University of Illinois, Chicago, Ill.
Robert Ellsworth Mohler, B S , A. B , 1914, professor of agriculture, McPherson College, McPherson, Kan
Mrs. Agnes Anderson Murray, A. M , 1913, Lawrence, Kan
R. K. Nabours, Ph D , 1910, professor of zoology, Kansas State Agricultural College, Manhattan, Kan.
C. F. Nelson, Ph. D , 1914, associate professor of physiological chemistry, University of Kansas, Lawrence, Kan
P. J. Newman, 1919, teacher and chemist, Manhattan, Kan.
H. H Nininger, 1921, department of botany, McPherson College, McPherson, Kan.
Nadine Nowlin, A M , 1917, assistant professor of zoology, University of Kansas, Lawrence, Kan.
H. N. Olson, A. B , 1905, professor of mathematics, Bethany College, Lindsborg, Kan
Earl O'Roke, 1917, instructor in zoology, South Dakota State College, Brookings, S Dak.
Fayette T. Owen, Ph. D., 1917, professor of chemistry, College of Emporia, Emporia, Kan.
S. L. Palmer, 1917, Hutchinson, Kan.
John H. Parker, 1918, assistant professor of crops, Kansas State Agricultural College, Manhattan, Kan.
Nellie M. Payne, 1920, assistant in entomology, Kansas State Agricultural College, Manhattan, Kan.
Larry M. Peace, A. M., 1904, demonstrator in botanical laboratories, University of Kansas, Lawrence, Kan.
Irving Perrine, geologist, Oklahoma City, Okla.
John C. Peterson, 1919, teacher, Manhattan, Kan.
S. E. Price, D. D., president Ottawa University, Ottawa, Kan.
G. E. Raburn, 1919, teacher, Kansas State Agricultural College, Manhattan, Kan.
G. R. Randall, 1921, agricultural director, Marysville, Kan.
Roy Rankin, 1919, professor of Chemistry, Fort Hays Kansas Normal School, Hays, Kan.
E. F. A. Reinisch, 1917, superintendent of parks, Topeka, Kan.
Mrs. C. I. Reed, 1918, instructor in zoölogy, University of Kansas, Lawrence, Kan.
C. I. Reed, 1920, assistant professor of physiology, University of Kansas, Lawrence, Kan.
W. E. Ringle, 1920, teacher, Pittsburg, Kan.
Vance N. Robb, 1921, ophthalmologist, Manhattan, Kan.

Eulalia E. Roseberry, B. S., 1909, professor of geography, State Manual Training Normal School, Pittsburg, Kan.

George E. Rex, 1911, Atchison, Topeka & Santa Fe Railway, Topeka.

W. R. B. Robertson, Ph. D., 1905, assistant professor of zoölogy, University of Kansas, Lawrence, Kan.

Elizabeth Rothermel, 1919, assistant professor of foods and nutrition, Kansas State Agricultural College, Manhattan, Kan.

Clifford S. Rude, 1918, assistant entomologist, Texas Experiment Station, College Station, Tex.

J. C. Russell, A M., 1911, professor of chemistry, McPherson College, McPherson, Kan.

D. C. Schaffner, A. M., 1903, professor of zoology, College of Emporia, Emporia, Kan.

Charles A Scott, 1919, nurseryman, Manhattan, Kan.

T H Scheffer, M S , 1903, bureau of biological survey, Puyallup, Wash.

M M Schmidt, 1914, cashier of bank, Summerfield, Kan

Sister M. Sebastian, Dodge City, Kan

George C. Shadd, professor of electrical engineering, University of Kansas, Lawrence, Kan.

N P. Sherwood, Ph. D., 1917, professor of bacteriology, University of Kansas, Lawrence, Kan

W. D Shewman, 1920, teacher of physics, Fort Hays Kansas Normal School, Hays, Kan.

J A G Shirk, M. S., 1904, professor of mathematics, State Manual Training Normal School, Pittsburg, Kan

C J Shirk, M S , 1905, professor of botany, Nebraska Wesleyan University, University Place, Neb

Ralph C Shuey, 1905, 3306 West Sixty-seventh street, Chicago, Ill.

Charles A Shull, Ph D , 1917, professor of botany, University of Kentucky, Lexington, Ky.

R. R Sigler, 1920, instructor in State Manual Training Normal School, Pittsburg, Kan.

Roger C Smith, 1921, teacher, Kansas State Agricultural College, Manhattan, Kan.

E Claude Smith, D O S , 1917, osteopath, Topeka, Kan

W. C Stevens, M S , 1890, professor of botany, University of Kansas, Lawrence, Kan.

S G Stewart, M D , 1904, Topeka, Kan.

O O Stoland, Ph D , 1918, professor of physiology, University of Kansas, Lawrence, Kan.

G. W. Stratton, Ph D , 1918, associate professor of chemistry, University of Kansas, Lawrence, Kan

C M Sterling, A. B , 1904, assistant professor of pharmacognosy, University of Kansas, Lawrence, Kan

Frank P. Strickland, jr , 1917, city chemist, Kansas City, Kan

John Sundwall, Ph D , M. D , University of Minnesota, Minneapolis, Minn

M C. Tanquary, Ph D., 1912, Texas Experiment Station, College Station, Tex

E. L Tague, A M , 1912, assistant professor of chemistry, Kansas State Agricultural College, Manhattan, Kan.

A C Terrill, E. M , A M., Baxter Springs, Kan.

Helen B. Thompson, 1919, Kansas State Agricultural College, Manhattan, Kan

George W. Tidd, 1914, Enid, Okla.

Eugene F. Tinker, 1919, Wesleyan University, Salina, Kan.

J. E. Todd, M. A., 1907, assistant professor of geology, University of Kansas, Lawrence, Kan.

David Train, 1907, Lindsborg, Kan.

Elbert S. Tucker, 1904, U. S. Entomological Laboratory, Tallulah, La.

W. H. Twenhofel, Ph. D., 1910, science hall, Madison, Wis.

Perley F. Walker, M. M. F., 1905, dean of the School of Engineering, University of Kansas, Lawrence, Kan.

Lalia V. Walling, A. M., 1918, instructor in physiology, University of Kansas, Lawrence, Kan.

Henry J. Waters, B. Sc., LL. D., 1909, editor Weekly Kansas City *Star,* Kansas City, Mo.

Charles H. Watson, 1919, teacher, Lawrence, Kan.

George N. Watson, A. B., B. Sc., assistant professor of pharmacy, University of Kansas, Lawrence, Kan.

Lawrence A. Walworth, 1913, taxidermist, Eleele, Kauai, Hawaii.

Edward R. Weidlein, A. M., professor of inorganic chemistry, University of Pittsburgh, Pittsburgh, Pa.

James R. Wells, 1920, instructor in biology, State Manual Training Normal School, Pittsburg, Kan.

E. A. White, A. M., 1904, assistant professor of chemistry, University of Kansas, Lawrence, Kan.

C. C. Williams, C. E., 1917, professor of railway engineering, University of Kansas, Lawrence, Kan.

Nettie Wismer, 1919, student, Manhattan, Kan.

W. B. Wilson, M. Sc., 1903, professor of biology, Ottawa University, Ottawa, Kan

Guy West Wilson, A. M., M. Sc., Fayette, Iowa.

Henry Irwin Woods, A. M., 1903, professor of physics and astronomy, Washburn College, Topeka, Kan.

Thomas A. Wood, B. S., 1909, professor of blacksmithing, assistant professor of mathematics, Fort Hays Kansas Normal School, Hays, Kan.

C. M. Young, B. S., E. M., 1920, professor of mining engineering, University of Kansas, Lawrence, Kan.

Percy Young, 1920, department of zoology, Cornell University, Ithaca, N. Y.

FIFTY-FIRST ANNUAL MEETING,
KANSAS ACADEMY OF SCIENCE.

Program of the Fifty-first Annual Meeting,
Manhattan, April 18, 19, 1919.

FRIDAY, APRIL 18.

10.00 a.m. Business meeting of the Academy.
Reading of papers.
1 30 p.m. President's address.
Address, President W. M. Jardine.
Address, Chancellor Frank Strong.
Reading of papers.
6 00 p.m. Banquet.
8·00 p.m. Address, Dr. H. B. Ward, University of Illinois Rapid Growth of Stream Pollution.

SATURDAY, APRIL 19.

10 00 a m. Business of the Academy.
Reading of papers.
1 30 p.m. Unfinished business.

PAPERS SUBMITTED FOR THE FIFTY-FIRST SESSION.

1. Patent Laws with Regard to the Protection of Chemical Industry. *L. E. Sayre.*
2. Inheritance and Parthenogenesis in the Grouse Locust, *Apotettix.* *R K. Nabours.*
3. Some Dragon Flies in Southeastern Kansas *Vernon C. Allison.*
4. Deficiency Diseases *J. S. Hughes.*
5. A List of Butterflies of Crawford County, Kansas *Vance Randolph*
6. The Weakening Effect of Continually Reproducing a Species of Plants by Artificial Methods. *E. F. A Reinish.*
7. Scientific Engineering Problems in Connection with Ordnance Manufacture. *R. A Seaton.*
8. Factors Influencing the Teaching of Science and Engineering *A. A. Potter.*
9. A Review of Literature on the Rusts of Oats, with Notes on Their Distribution in the United States. *John H. Parker*
10. A Study of the Bacteria Causing Spoilage in Canned Asparagus. *L. D. Bushnell.*
11. The Parallel Formation of Carbon Dioxide, Ammonia and Nitrates in Soils. *P. L. Gainey.*
12. The Use of Calcium Carbonate in Nitrogen Fixation Experiments *P. L Gainey.*
13. Explorations in the Permian of Texas and the Kansas Chalk in 1918. *Charles H. Sternberg.*
14. A Preliminary List of the Algæ of Kansas. *James B. McNaught.*
15. A Classification of School Subjects, Based on Function. *Lyman C. Wooster.*
16. Are There Seventeen Varieties of Elms in Kansas? Why? *Lyman C. Wooster.*
17. Botanical Notes for 1918-1919. *Frank U. G. Agrelius.*
18. Food Value of the Banana. *J. M. McWharf.*
19. The "Flu" Among the Navajos. *Albert B. Reagan.*
20. Glacial Deposits in Pine River Valley, Colorado. *Albert B. Reagan.*
21. Plague Among Chickens in Central Iowa During the Summer of 1918. *Albert B. Reagan.*
22. Possible Eocene Glacial Deposits in the Ft. Apache Region, Arizona. *Albert B. Reagan.*
23. Some Suggestions on Climate. *Albert B. Reagan.*
24. Scientific Measurement of the Achievements of Pupils. *F. J. Kelly.*
25. The Action of Bromine on p-Iodoaniline. *P. E. Laird.*
26. Studies of Insects Bred and Collected from the American Mistletoe. *Elbert S. Tucker.*
27. Alcoholism and Heredity. *Robert E. Mohler.*
28. Notes on Some Fungi from Eastern Kansas. *Guy West Wilson.*
29. A Plus or Transcendent Factor in Evolution. *H. J. Harney.*
30. Edible Mushrooms of Kansas. *Elam Bartholomew.*

31. More Evidence that the Platte River of Nebraska Once Joined the Grand River of Missouri. *James E. Todd.*
32. The *Eleodes* of Riley County, Kansas. *James W. McColloch.*
33. The *Lachnosterna* of the Vicinity of Manhattan, Kansas *James W. McColloch and Wm. P. Hayes*
34. Larval Trematodes from the Laramie Plains *Earl O'Roke*
35. A Study of the Islets of Langerhons and the Suprarenal Tissue in Thyroidless and Pituitaryless Larvæ of Rana and Bufo *Alice L. Brown*
36. Notes on *Strategus* *W. Knaus.*
37. A New Check List of Coleoptera *W. Knaus.*
38. The Economic Results of High-bred Stock in the Communities *Robert D. Bussey.*
39. Elementary Reflex Mechanisms in Vertebræ *Geo. E Coghill.*
40. Variability in Growth and Food Consumption of the Albino Mouse After Extended Periods of Suppression of Growth *Helen B. Thompson.*
41. Wintering Bees. *J. H Merrill.*
42. The Organization of the Science Teaching on an After-war Program on Education. *O. P. Dellinger.*
43. Plant Diseases Heretofore Unreported in Kansas in 1914, 1915, 1916 and 1917. *L. E. Melchers.*
44 Plant Disease Survey Report for Kansas in 1918 *L. E Melchers*
45 The House Fly and Fowl Tapeworm Transmission *James E Ackert.*
46. Studies on the Life History of *Heterakis papillosa*, a Fowl Nematode. *Eva E. Wood.*
47 Studies on the Occurrence and Development of *Ascaridia perspicillum*, Parasitic in Chickens. *Bertha L Danheim*
48. A New Method of Seeding Wheat to Prevent Winterkilling *S C. Salmon*
49. A Study of Losses of Feed Constituents Which Take Place in Stacking Alfalfa *C O Swanson.*
50. A Secondary Sexual Dimorphism in Domestic Birds *W. A Lippincott*
51. Intensive Training in Radio Operation for War Service. *J O Hamilton*
52. Special Instruments for Measuring Inductance and Capacity *E. A. Stewart*
53. Kansas Rhyncophora in the Collection of the Kansas Agricultural College *Wm P Hayes.*
54. Correlation Between Wind Flow and Evaporation *Charles A. Shull*
55. A Study of Influenza in the University of Kansas *N. P Sherwood.*
56. Further Study of Secretions of Internal Glands of Amphibian Larvæ *Bennett M. Allen.*
57. Some Special Chromosomes of Crickets *W. J Baumgartner.*
58. Helium as a Balloon Gas *H. P. Cady.*
59. Some Embryological Models *Mary T. Harman.*
60. Psychology in the War. *W. S. Hunter.*
61. Life and Works of Samuel W. Williston *Erasmus Haworth.*

Minutes of the Fifty-first Annual Meeting.

The fifty-first annual meeting of the Kansas Academy of Science was opened by President L. D. Havenhill at 10·30 o'clock, Friday, April 18, 1919, in the lecture room of Science Hall, Kansas State Agricultural College, Manhattan, Kan.

Dr. J. T. Willard made a few introductory remarks in which he welcomed the visitors to Manhattan and invited them to visit the science departments of the school. Dean L. E. Sayre responded in a happy manner and voiced the delight of the members in again visiting Manhattan after so long an absence.

The printed minutes of the last meeting were distributed, to be read by the members; the secretary's report was read and accepted. President Havenhill, who had been acting as treasurer since the resignation of Mr. Bruckmiller, gave his report, which was accepted.

Upon motion of Dean Sayre, the executive committee was urged to make every effort to induce the University authorities to provide an office for the Academy in the new administration building at the University of Kansas.

The committee on membership presented the names of thirty-three applicants, who were elected to membership. They are as follows: Ray I. Brewster,

Lawrence, Kan.; H. W. Brubaker, Manhattan, Kan.; Elizabeth Brown, Marysville, Kan.; Charles H. Brooks, Stockton, Kan.; Bertha L. Danheim, Manhattan, Kan.; H. M. Elsey, Lawrence, Kan.; W. L. Eickenberry, Lawrence, Kan.; P. L. Gainey, Manhattan, Kan.; J. O. Hamilton, Manhattan, Kan.; Wm. P. Hayes, Manhattan, Kan.; W. S. Hunter, Lawrence, Kan.; F. J. Kelly, Lawrence, Kan.; P. B. Lawson, Lawrence, Kan.; Karl A. Menninger, Topeka, Kan.; James B. McNaught, Lawrence, Kan.; Bess J. McKittrick, Manhattan, Kan.; J. M. Merrill, Manhattan, Kan.; F. A. Marlatt, Manhattan, Kan.; P. J. Newman, Manhattan, Kan.; John C. Peterson, Manhattan, Kan.; Nellie M. Payne, Manhattan, Kan.; Geo. E. Rayburn, Manhattan, Kan.; Roy Rankin, Hays, Kan.; Elizabeth Rothermel, Manhattan, Kan.; Geo. C. Shadd, Lawrence, Kan.; E. A. Stewart, Manhattan, Kan.; Chas. A. Scott, Manhattan, Kan.; Chas. H. Watson, Lawrence, Kan.; Nellie Wismer, Manhattan, Kan.

The following were elected to life membership A. M. Nissen, Wetmore, Kan.; F. F. Crevecoeur, Onaga, Kan.; and A. O. Garrett, Salt Lake City.

The committee on research reported, through Doctor Willard, that no action had been taken, and the committee was continued.

The president appointed the standing committees, as follows.

Committee on Nominations: L. E. Sayre, J. T. Willard, O. P. Dellinger.

Committee on Resolutions. Leroy Hughbanks, L. C. Wooster, W. A. Harshbarger.

Committee on Program. J. E. Ackert, O. P. Dellinger, W. J. Baumgartner.

Auditing Committee: W. Knaus, O. P. Dellinger.

Membership Committee The secretary, J. E Ackert, J. A. Yates.

Publication Committee: W A. Harshbarger, L. C. Wooster, J. T. Willard.

Press Committee. Leroy Hughbanks, L. E. Sayre, Elam Bartholomew.

Legislative Committee: J. M. McWharf, J. A. Yates, W. A. Harshbarger, L. E. Sayre.

Research Committee: J. T. Willard, E. H. S. Bailey, J. A. Yates, B. M. Allen.

A communication was read to the Academy from the American Association for the Advancement of Science, in which it invited the Kansas Academy of Science to become affiliated with it. On motion of Doctor Nabours, the matter was left until such time as Doctor Ward, a member of the American Association, could speak to the Academy on the matter. The Academy adjourned to meet at 1·30.

FRIDAY AFTERNOON.

The Academy convened pursuant to adjournment, and the papers on the program were called for in the order they were listed.

Vice President Nabours took the chair, and President Havenhill delivered his address, "Cultivation of Medicinal Plants." This paper was very interesting and was illustrated by numerous slides.

Dr. H. B. Ward, of the American Association for the Advancement of Science, was introduced and explained what the affiliation of the Academy to that association would mean to the Academy. If the Academy desires to affiliate there will be a fee of three dollars, two of which goes to the American Association and one for local dues. This amount also pays for a subscription to *Science*. There are full memberships by which the entire membership of the Academy become members of the American Association and limited memberships by which individual members may join.

On motion of O. P. Dellinger, the matter was left to a committee of three, who were to report before the meeting adjourned. The president appointed Doctor Nabours, Professor Dellinger and Dean Sayre.

President W. M. Jardine, of the Agricultural College, addressed the Academy on the work of the College and told of some of the special problems of the Kansas Agricultural Experiment Station. He said there should be a special bond of sympathy between the Kansas Academy of Science and the Kansas State Agricultural College.

On motion of Mr. Hughbanks, the meeting adjourned to meet at 11 o'clock Saturday morning to allow a tour of the College and to enable the members to attend the students' convocation, which was to be addressed at 10 o'clock by Doctor Ward.

At 6 o'clock, on the invitation of Doctor Jardine, the Academy repaired to one of the army barracks, where a banquet was served to over 100 people. Dean Sayre acted as toastmaster of the occasion and treated the crowd to an enjoyable program of toasts by members and visitors. At 8 o'clock Dr. Henry B. Ward, professor of zoology at the University of Illinois, gave a highly interesting lecture in the parlor of Domestic Science Hall. His address was on "Growth of Stream Pollution."

SATURDAY MORNING.

By order of the president, business was dispensed with and the short morning session was spent in reading papers.

SATURDAY AFTERNOON.

The Academy reconvened at 1·30 o'clock. Dean Sayre moved that the minutes of the last meeting, as printed, be approved. Carried.

The nominating committee made the following report

President, R. K. Nabours, Manhattan; first vice president, B. M. Allen, Lawrence; second vice president, O P. Dellinger, Pittsburg; treasurer, L. D. Havenhill, Lawrence; secretary, E. A. White, Lawrence. Executive council· Warren Knaus, McPherson; W. A. Harshbarger, Topeka, Leroy Hughbanks, Anthony.

By motion, the rules were suspended and the secretary instructed to cast the ballot of the Academy for the nominees. The ballot being cast, the nominees were declared elected.

Professor Harshbarger reported, for the committee on legislation, that the bill to abolish the Academy was killed when introduced into the senate and house.

The committee appointed to consider the affiliation of the Academy with the American Association for the Advancement of Science made the following report:

Your committee to consider the question of affiliation with the American Association for the Advancement of Science would recommend that the Academy, through its secretary, signifies to the proper officials of the American Association that it favors the proposed affiliation and recommends that the details of this affiliation be arranged by the executive committee, with power to act.

O. P. Dellinger.
Robert K. Nabours.
L. E. Sayre.

Professor Harshbarger recommended that Doctor Cady's paper on "Helium" be printed and mailed to the members of the legislature. Dean Sayre recommended the matter be left to the committee on publication. The president recommended that separates on different subjects be sent to the part of the state most interested in that subject.

On motion of Doctor Sayre, a committee composed of the secretary, Dean Sayre and Professor Harshbarger was appointed to revise the constitution and by-laws, committee to report at the next meeting.

The auditing committee reported the treasurer's report correct as submitted.

On motion of Professor Ackert, Doctor Sayre was given the privilege of the floor to present matters concerning the "League to Enforce Peace."

The committee on resolutions made the following report, which was adopted

Be it resolved, That the Kansas Academy of Science, in its fifty-first annual session, hereby express its hearty sympathy with the President of the United States in his untiring efforts to consummate a permanent League of Nations We further pledge ourselves to lend him our support and influence in bringing about the elevation of the people of the world

Be it further resolved, That a copy of this resolution be forwarded at once, by our secretary, to the White House

Be it resolved, That the most sincere thanks of the Academy are due the Kansas Agricultural College for the genuine welcome accorded her guests upon this occasion, and to the members of the faculty who have added their special efforts toward the complete success of the meeting In this connection we would not forget to mention the excellent banquet tendered the members of the Academy and the trip to the experiment station

O P. DELLINGER
ROY RANKIN

The reading of papers was then resumed and continued until the Academy adjourned E A. WHITE, *Secretary*.

TREASURER'S REPORT.

Receipts	
Collected from dues	$187.00
Interest on deposits	19.00
Sale of Transactions	15.30
Other sources	37.32
Balance from previous year	640.20
Total	$898.82
Expenditures	144.86
Balance cash on hand	$753.96

L. D. HAVENHILL, *Acting Treasurer*.

FIFTY-SECOND ANNUAL MEETING,

KANSAS ACADEMY OF SCIENCE.

Program of the Fifty-second Annual Meeting,

Pittsburg, April 23, 24, 1920.

FRIDAY, APRIL 23.

10:00 a.m. Business meeting.
Reading of papers.
1:30 p.m. Business meeting.
Reading of papers.
6:00 p.m. Dinner.
8:00 p.m. Presidential address, Bennett M. Allen.
Paper, Mining Industries of Kansas, C. M. Young.

SATURDAY, APRIL 24.

8 30 a.m. Business meeting.
Field trip, given by the local branch of the Kansas Academy of Science and by the Chamber of Commerce of Pittsburg.

PAPERS SUBMITTED FOR THE FIFTY-SECOND SESSION.

1 Factors in the Computation of Farm Statistics *I. D Graham and F D Hammatt*
2. Standards of Purity for Medicinal Agents *L. E Sayre*
3. Botanical Notes for 1919 *Frank U. G Agrelius*
4. Decay of Mountains *Lyman C. Wooster*
5. Preliminary Lists of Insects of the Sorghum Field. *Wm P Hayes*
6. Some Observations on the Formation of Kansas Coals. *J. A. Yates.*
7 How to Use an Aneroid Satisfactorily in Determining Altitudes. *J. E. Todd.*
8. Archæological Notes on Lower and Middle Pine River Valley, Colorado, and the Tuba-Kayenta Region, Arizona *Albert B. Reagan.*
9. A List of the Cicadellidæ of Kansas *Paul B. Lawson*
10. A List of the Grasses of Douglas County *Paul B. Lawson.*
11. Field Work in Kansas and Texas *Charles H. Sternberg.*
12. Education, Physical and Mental *J M. McWharf.*
13. Predictive Value of Intelligence Tests upon College Freshmen *John C. Peterson*
14. An Annotated List of Some Kansas Pleurosticti. (Scarabæidæ). *J W. McColloch and Wm P. Hayes.*
15. Development of Power Generation in Southeast Kansas and Southwest Missouri. *J. A. G. Shirk.*
16. Fossils from the Western Front *Frank P. Strickland*
17. A Preliminary Study of the Life History and Habits of *Dione vanillæ* Linn. *Van Randolph.*
18. Wood Sections as a Help to Students in Woodworking *Ralph Wells.*
19. A Dry-Weather Mosquito Plague *O P. Dellinger.*
20. A Reported Strange Animal. *O. P. Dellinger.*
21. Report of Committee on Research. *P. F. Walker.*
22. Collecting Coleoptera in Southwest Utah in 1919. *Warren Knaus.*
23. Mining Industries of Kansas. *C M. Young.*
24. The Relation of the Glands of Intestinal Secretion to Growth and Development. (President's Address.) *Bennett M. Allen.*
25 A Kitchen Disinfectant. *F. A. Patty and L. E. Sayre.*

Minutes of the Fifty-second Annual Meeting.

The fifty-second annual meeting of the Academy was held at the State Manual Training Normal School, Pittsburg, Kan., April 23 and 24, 1920.

Dr. R. K. Nabours, the elected president, having left the country, Dr. B. M. Allen, the first vice president, assumed the office of president and presided at the meetings. Sessions were held at 10 a. m., 1:30 p. m. and 8 p. m. Friday and a business session Saturday at 8 a. m.

Many of the papers, the subjects of which were printed in the program, were read at these meetings. At the first session the following committees were appointed by the president:

Nominations: Knaus, Harshbarger.

Program: Yates, Ringel, White.

Auditing: Bailey, Havenhill, Harshbarger.

Membership: Rankin, Willard.

Publications: Hughbanks, Sayre.

Press: Dellinger, Ringel, Sayre

Legislation: McWharf, Hughbanks, Bailey

Research: Ackert, Dains, Willard, Yates

The membership committee recommended that Dr F. B. Dains be elected a life member and recommended the following for active members: R. D. E. Matthews, Pittsburg, Kan.; W. E. Hoffman, Lawrence, Kan.; Geo. V. Emery, Pittsburg, Kan.; Richard R. Sigler, Pittsburg, Kan.; W. E. Ringle, Pittsburg, Kan.; C. M. Young, Lawrence, Kan.; W. D. Shewman, Hays, Kan.; H. B. Hungerford, Lawrence, Kan ; Percy Young, Lawrence, Kan.; J. R. Wells, Pittsburg, Kan.; A. T. Dunham, Pittsburg, Kan.; C. I. Reed, Lawrence, Kan.

They were all elected.

Professor Willard, for the research committee, reported as follows:

"The committee on research calls attention to the organization of the Kansas Research Council as an organization which is adapted to doing better and more completely anything that our committee might do, and recommends that our committee be continued for the purpose of cooperating with the research council and assisting it in connection with the research work of members of the Academy who are not members of the council."

The nominating committee reported the following nominations for officers: President, O. P. Dellinger; first vice president, Roy Rankin; second vice president, W. P. Hayes; treasurer, L. D. Havenhill; secretary, E. A. White. Executive council: J. T. Willard, W. A. Harshbarger, W. J. Baumgartner, F. U. G. Agrelius.

They were unanimously elected.

At the morning session on Friday the following changes in the constitution were proposed, and were adopted at the business meeting Saturday morning:

SEC. 3. The members of this Academy shall consist of two general classes—honorary and active.

(1) *Active members* shall be classified as local members and national members. Local members shall be those who are members of this Academy only. Local members may be elected at any time by the committee on membership, which shall consist of the secretary and two other members appointed by the president, annually. Annual members shall pay a fee of one dollar and annual dues of one dollar; but the secretary and treasurer shall be exempt

from the payment of dues during the years of their service. Any person who shall at one time contribute $20 to the funds of this Academy may be elected a *life member* of the Academy, free of assessment Any member who has paid dues to the Academy for ten consecutive years, or who has been legally exempt during any portion of that time, may be elected a *life member* on the payment of $10 Any member who has been a member of this Academy in good standing for twenty years may be elected a *life member* without payment of further fees or dues *Honorary members* may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case, a two-thirds vote of members present shall elect to honorary or life membership

(2) *National members* shall consist of those who are also members of the American Association for the Advancement of Science Each national member, except life members of the Academy, shall pay, or shall have paid, an initiation fee of one dollar to this Academy, and shall pay an annual fee equal to the annual fee assessed by the American Association for the Advancement of Science. The Academy shall be entitled to one dollar annually as its share of the above fee. Life members of the Academy shall pay the assessment of the American Association for the Advancement of Science less one dollar, and all of this shall be sent to the American Association

The classification of members, together with the fees to be paid, is as follows

1 Honorary No dues
2 Active
  (1) Local
    (a) Annual Dues, $1 per year
    (b) Life No dues
  (2) National
    (a) Local life, national annual Dues, $1 less than the assessment of the A A A S.
    (b) Local life, national life No dues
    (c) Local annual, national annual Dues, an amount equal to the assessment of the A. A A S, one dollar of which the Academy shall keep
    (d) Local annual, national life Dues, $1 per year

SEC 7 This Academy shall have an executive council, consisting of the president, the secretary, the treasurer, the vice presidents, and four other members to be nominated by the nominating committee and elected as the other officers This council shall have general oversight of the Academy not otherwise given by this constitution to officers or committees

The committee on resolutions submitted the following report

Resolved, That in view of the excellent papers presented at the annual sessions of the Academy, we pledge ourselves to endeavor to increase the membership of the Academy and the attendance at its meetings

Be it further resolved, That the most cordial thanks of the Academy be tendered to the faculty of the Kansas State Manual Training Normal School for their courtesy in presenting the work of the school, and their generous hospitality in respect to local transportation, and especially for the splendid banquet given in honor of the visiting members

Be it further resolved, That the excursion to the Ozarks and intermediate points of interest is one which will long be remembered as a mark of the friendly interest of the Pittsburg members in the pleasure and profit of their scientific coworkers

This report was made before the trip to the Ozarks began, and the prediction of a pleasant and profitable trip was not overestimated.

Leaving Pittsburg about 9 o'clock Saturday morning, we traveled in automobiles over level prairie land, then through wooded hills, along valleys, upstream and downstream, through the beautiful city of Joplin and ten miles beyond, where we stopped for lunch by the roadside, where a river of water flowed from under the rocks. After a short stop we proceeded through narrow valleys beyond the city called Neosho, to the United States fish hatchery. From here the return trip was begun, eating at the same spring as at noon, arriving in Pittsburg about 9 o'clock.

SECRETARY'S REPORT.

Through the membership committee, since our last meeting we have added sixteen new members, as follows: J. Willard Hershey, professor of chemistry, McPherson College, McPherson, Kan.; Roger C. Smith, assistant professor of entomology, Kansas State Agricultural College, Manhattan, Kan.; Howard Kay Gloyd, student, Ottawa University, Ottawa, Kan.; Joseph H. Collins, teacher of science, Western University, Kansas City, Kan.; Jean Bogert, Ph. D., professor of food economics and nutrition, Kansas State Agricultural College, Manhattan, Kan.; H. C. Ericson, superintendent state free employment bureau, Topeka, Kan ; Howard de Forest, assistant professor of botany, University of Kansas, Lawrence, Kan.; Frank L. Fleener, teacher of geology, University of Kansas, Lawrence, Kan ; Louis Hay, teacher of physics and mathematics, Augusta high school, Augusta, Kan.; Chas. E. Johnson, associate professor of zoology, University of Kansas, Lawrence, Kan.; E. G. Kelly, entomologist, Kansas State Agricultural College, Manhattan, Kan.; Harold R. Laing, teacher of chemistry and botany, Augusta high school, Augusta, Kan.; Harvey N. Nininger, professor of biology, McPherson College, McPherson, Kan ; C. R Randall, agricultural director, Marysville, Kan ; Dinsmore Alter, professor of astronomy, University of Kansas, Lawrence, Kan.; Ethel Ann Jones, instructor in chemistry, University of Kansas, Lawrence, Kan.

This makes a total membership now of 246, of whom 12 are honorary, 38 are life and 196 are annual. Of the life and annual members, 65 are national; that is, they belong to the American Association for the Advancement of Science and pay their dues through the Academy.

As soon as the adoption of the amended section 3 of our constitution was reported to the American Association for the Advancement of Science, their secretary, at Washington, reported the Academy as affiliated, and sent to the Academy a check for $56, our share of dues which they had already collected for 1920.

Since then we have been trying to get in correspondence with all members of the American Association for the Advancement of Science who live in Kansas and give them the benefit of the Academy without further expense to them. All Kansans who belong to the American Association should belong to the Academy. All new members of the National Association will save $5 by joining through the Academy.

The Academy library is in the same location and condition as it was when the last report was made. Many valuable exchanges have been received during the year, and many of our transactions have been sent out. We now have the volumes from one to twenty-nine in groups, so that a complete set may be made up in a few minutes. E. A. White, *Secretary.*

REPORT OF THE TREASURER.

Pittsburg, Kan., April 23, 1920.

Receipts:

Dues	$99.00
Interest on deposits	30.78
Sale of Transactions	5.50
Total	$135.28
Balance from previous year	753.96
Grand total	$889.24
Expenses	89.11
Balance on hand	$800.13

L. D. Havenhill, *Treasurer.*

FIFTY-THIRD ANNUAL MEETING,

KANSAS ACADEMY OF SCIENCE.

Program of the Fifty-third Annual Meeting,

Lawrence, February 18, 19, 1921.

FRIDAY, FEBRUARY 18.

10:30 a.m. Reading of minutes of last meeting and secretary's report.
Reading of papers.
Appointment of committees.
2.30 p.m. Business meeting.
Reading of papers.
6:00 p.m. Dinner by local members to visiting members.
Some good talks.
8:00 p.m. Lecture and papers.

SATURDAY, FEBRUARY 19.

9.30 a.m. Unfinished business.
Election of officers.
Reading of papers.

PAPERS SUBMITTED FOR THE FIFTY-THIRD SESSION.

1. The Coleoptera of Southwest Utah. *W W. Knaus*
2. Notes on *Buprestis confluens* Say. *W. W. Knaus*
3. An Expedition to Peshawar, N W Province, India (1920) *R K. Nabours*
4. Restoring Zoology to its Proper Place in the College Curriculum *H. H Ninninger*
5. Public Baths. *J M McWharf.*
6. Color in Nature *J E Todd*
7. A New Nesting Record for the Pine Siskin *F. F Crevecoeur*
8. Additions to the List of Kansas Lepidoptera *F. F Crevecoeur*
9. Additions to the List of Kansas Hymenoptera *F. F. Crevecoeur*
10. Some Practical Applications of Disinfectants (Germicides), Antiseptics and Deodorants. *L. E. Sayre.*
11. Botanical Notes for 1920. *Frank Agrelius.*
12. Archæology of the Tuba-Kayenta Region *A B. Reagan.*
13. Some Notes on the Lummi-Nooksack Indians, Washington *A B. Reagan.*
14. Flood Myth of the Bois Fort Chippewas *A. B. Reagan.*
15. Hunting and Fishing of Various Tribes of Indians. *A. B. Reagan.*
16. Insect Pests of Stored Rice *Elbert S. Tucker.*
17. Birds: Their Life and Activities. *O. P. Dellinger.*
18. A New Alfalfa-hay Worm Near Manhattan, Kan. *Nellie M. Payne.*
19. An Annotated Bibliography of North American References to *Lachnosterna*. *Wm. P. Hayes.*
20. Importance of the Primitive Instincts to the Scientist. *L C. Wooster.*
21. Volcanic Pumice in Kansas. *L. C. Wooster.*
22. Coyote Pests. *C. H. Sternberg.*
23. Cretaceans of Southern California. *Chas. H. Sternberg.*
24. The Reciprocal Relations of Soil and Insects, with Special Considerations of the Thermal Factor. *James W. McColloch.*
25. Frogs and Frogging. *E. C. O'Roke.*
26. Peace Time Problems Grown Out of the Chemical Warfare Service. *C. I. Reed.*
27. Ground-water Level. *W. A. Cook.*
28. Further Studies in Temperance as Affecting the Development of the Chick. *Mary T. Harman.*
29. The Importance of Abandoning the Use of Trivial Names, Many of Which Were Used in Alchemical Days, for Commercial Products. *E. H. S. Bailey.*

30. Hawaii: Its Peoples, Customs and Scenic Wonders. *L. A. Walworth.*
31. State Parks. *H. de Forest.*
32. The Relation of Buried Mountains in Kansas to Oil Production. *Raymond C. Moore.*
33. The Effect of Cigarette Smoke Upon the Rate of Growth of Young Rabbits. *W. J. Baumgartner.*
34. On the Preparation of the Aromatic Mustard Oils *F. B. Dains and C. P. Olander.*
35. Notes on the Conductivity of Solutions. *H M. Elsey.*
36. A Method for Determining Single Potential Differences. *H P. Cady and H. M. Elsey.*
37. The Germicidal Value of the Commercial Disinfectants of the Chlorine Group. *G. N. Watson.*
38. A Possible Rainfall Period Equal to One-ninth the Sun-spot Period. *Dinsmore Alter.*
39. The Effect of Boiling upon the Iodine Value of Lubricating Oils *H. C. Allen and H. W. Palkowsky.*
40. The Industrial Research Movement of To-day. *W. F. Faragher.*
41. Notes on Values of Industrial and Utility Properties *P. F. Walker.*
42. The Development of the Organ of Hearing *Hubert S Sheppard.*
43. Factors of Control in the Development of Conduction Paths in the Brain. *G. E. Coghill.*
44. On the Production of Hydrocyanic Acid by *Bacillus pyocyaneous* *A F. Patty and N P Sherwood*
45. Further Studies on Influenza *N P. Sherwood and J Welker.*
46. Further Studies on Influenza. *O O. Stoland and N. P Sherwood.*

Minutes of the Fifty-third Annual Meeting.

The fifty-third annual meeting of the Kansas Academy of Science met in the chemistry lecture room of the University of Kansas, Lawrence, at 10 o'clock, February 18, 1921, and was called to order by the president, Prof. O. P Dellinger.

The first order of the morning was the reading of the minutes of the previous meeting by the secretary, which were approved.

The secretary gave his annual report, which was also approved.

The President appointed the following committees:

Program Committee: De Forest, Rankin, Watson.

Resolution Committee: McWharf, Knaus, Harman.

The local committee reported that the morning session would continue until 12 o'clock, adjourning until 2 o'clock, the session to continue until 4:30 o'clock, at which time the Academy was invited to attend the Sherwood Eddy meeting in Frazer Hall. At 6.30 a complimentary dinner to visitors would be held at Plymouth Parish House. Papers were read by W. Knaus, J. M. McWharf and G. E. Coghill, after which the session was adjourned until 2 o'clock.

The afternoon session was called to order by the president, who appointed the following further committees:

Nominating Committee: Willard, Sayre, Wooster.

Auditing Committee: B. M. Allen, Nabours, Ninninger.

Membership Committee: The secretary, Rankin, Harman, Coghill.

Publishing Committee: Dains, Willard.

Press Committee: Bailey, Baumgartner, Harshbarger.

Legislative Committee: McWharf, Harshbarger, Bailey, Hughbanks.

Research Committee: B. M. Allen, Ackert, Dains, Willard, Yates.

The reading of papers was resumed by the following members: H. N. Ninninger, Mary T. Harman, C. I. Reed.

H. de Forest had been appointed by the Ecological Society as its representative in this state, and as such representative gave a paper on state parks. His paper was a plea to preserve places of beauty and historical interest in

the state, and asked that a committee be appointed from the Academy to assist him in that work.

Doctor Bailey moved that a committee of three be appointed by the president to coöperate with Doctor de Forest in this work.

The motion carried and the following were appointed: Dr. H. de Forest, chairman; Prof Roy Rankin, Dr. R. K. Nabours, Dr. R. C. Moore.

On Friday evening the Academy, with a number of interested guests, met at the parish house of the Congregational Church to enjoy a banquet tendered the visiting members by the local society. After the repast Doctor Willard acted as toastmaster in a most happy way, and called on Dean Kelly, Professor Dellinger, Professor Rankin, Dean Sayre, Doctor Bailey, Doctor Wooster and Miss Meeker, who responded to Doctor Willard's call in a most interesting manner. A vote of thanks was given the hosts of the evening for the splendid meal.

At 8 o'clock the president, Professor Dellinger, gave his annual address, taking as his subject, "Birds: Their Habits and Environment," which he handled in an able and interesting way. Professor Alter gave a paper on "A Possible Rainfall Period Equal to One-ninth the Sun-spot Period," which called forth much discussion, especially as to the probability of dry or wet weather for the coming season.

On Saturday morning the meeting was opened by the reading of the treasurer's report, which was referred to the auditing committee and approved by it.

The nominating committee made its report as follows.

President, Roy Rankin, Hays; first vice president, R. K Nabours, Manhattan; second vice president, W. R. B. Robertson, Lawrence, secretary, E. A. White, Lawrence; treasurer, L. D. Havenhill, Lawrence Executive Council: Dr. Mary T. Harman, Manhattan; W. J. Baumgartner, Lawrence; Frank U. G. Agrelius, Emporia; W. A. Harshbarger, Topeka.

The secretary was instructed to cast the vote for the officers nominated, and they were declared unanimously elected.

Doctor Elsey made the following motion. That authors estimate the time required for their papers, and those desiring overtime must obtain permission for the same from the executive committee.

Papers were read by the following members. Nabours, Wooster, Cady, Elsey, Walworth, Sherwood, Walker, Shephard, Agrelius and Bailey.

On motion of Doctor Bailey, the time and place of the next meeting was left to the executive committee.

The resolutions committee made the following report, which was accepted:

It is resolved, That the thanks of the Kansas Academy of Science are due to the authorities and faculty of the State University for furnishing rooms for the meetings of the fifty-third annual sessions of the Academy and for other courtesies shown.

It is further resolved, That the visiting members of the Academy tender the resident members their appreciation for the banquet served the evening of the first day's sessions.

The Academy adjourned to meet at the call of the executive committee.

REPORT OF THE TREASURER.

Expenses of the secretary	$54.39
Traveling expenses of the executive committee	26.54
Total expenses, 1921	$80.93
Paid in part from Academy money appropriated last year	41.22
Balance for this year's expense	$39.71

Receipts brought forward	$800.13
Received from dues	133.00
Interest	31.87
Received from sale of Transactions	1.00
Total receipts	$966 00
Total expenses	39.71
Balance on hand	$926.29

L. D. HAVENHILL, *Treasurer.*

PART II.

PAPERS—FIFTY-FIRST ANNUAL MEETING.

TITLES OF PAPERS,

FIFTY-FIRST ANNUAL MEETING.

The Cultivation of Medicinal Plants.

(Address of the retiring president, fifty-first annual meeting.)

L D HAVENHILL.

Members of the Kansas Academy of Science, Ladies and Gentlemen: It is not of my own volition, but to comply with a by-law of this Academy, adopted more than a generation ago, that I appear before you this afternoon.

Nearly twenty-five years ago, when the Academy met at this College, Professor Sayre, dean of the school of pharmacy of the State University, as your president, addressed you on the subject of "Medicinal Plants." Now, after a lapse of nearly a quarter of a century, and the Academy again assembled in Manhattan, another member of the faculty of the same school of pharmacy is about to speak to you on a kindred subject, "The Cultivation of Medicinal Plants."

Professor Sayre has been from the very first an ardent advocate of the cultivation of medicinal plants in the United States, and particularly in Kansas. The seeds sown by him have as yet failed to germinate in Kansas, though, strange to say, those wafted into the adjoining states both to the north and to the south have rooted, blossomed and fruited.

Medicinal plants have always afforded a subject of great interest, and their cultivation dates back many centuries before the Christian era. Drug cultivation in the United States as a whole, aside from those plants which serve two purposes—medicinal and industrial—and in which value as a drug is the least important, have received but little attention. In this class are such plants as cotton, tobacco, flax, hemp, hops, mustard, castor beans, etc. The explanation for this lack of more general consideration may, of course, be found in the limited and sometimes uncertain market for drugs; the easily accessible supplies, under normal conditions, from foreign countries; the lack of knowledge in their cultivation; and the cost of labor.

The recent strenuous times have brought to us a lesson on the desirability of developing our own resources more evenly in all directions. The question now is, Will we profit by it, or will we again drift back into the old, easy channels?

In the past if some nation by reason of her more frugal habits was able to develop a certain line of industry and supply our needs at a price below that at which we could produce the same goods and at the same time realize a profit commensurate with that obtainable in other lines, we were content to have her do so. Profit seems ever to have been the prime incentive for the development of our industries, and the greater the profit the greater has been the development.

The rapid production of various synthetic drugs of foreign manufacture, together with skillful advertising, has resulted in the undoing of our one-time favorite herb doctor with his store of remedies derived from the vegetable world, and particularly from his own garden. The demand for these foreign synthetics has enormously increased, while that for our local drugs has materially declined. The vegetable materia medica has become greatly narrowed, and, strange to say, that which remains of it is largely foreign grown. It was, therefore, to be expected, when ocean commerce began to be interrupted and

the great drug markets of the world—Hamburg, Trieste and London—practically closed, that a marked drug scarcity was experienced in this country, and that the prices of all drugs should advance from ten to several hundred per cent. This shortage in some instances became very acute, and but for the foresight of certain individuals might have become extremely serious.

Drug cultivation, while not entirely new in this country, has, for reasons already mentioned, never flourished here. What has been done has been largely in the way of experimental gardening rather than farming

Our supply of native American drugs has until recently been derived almost entirely from wild plants. Strange to say, in spite of our large medicinal flora, but one plant, ginseng, has up to the present attained any importance in our exports, and but few of our native plants have attracted any attention abroad On the other hand, we have been importing between fifteen and twenty million dollars' worth of drugs annually, of which a considerable part could be raised in this country, while no inconsiderable quantity might be collected from plants flourishing here, and which in some cases are considered as pests. This is particularly true of drugs such as dandelion, yellow dock, poke, burdock, jimson, corn silk, red-clover blossoms, etc

The time when the cultivation of drugs began in America does not seem to be recorded. The early settlers are known to have brought seeds with them from Europe, and many of the plants so introduced have, like the people who brought them, become naturalized and spread to the four corners of the country. We have visible and lasting evidences of this in several well-known plants, particularly in dandelion and stramonium The last-named plant, commonly known as jimson weed—a contraction of Jamestown weed—thereby has its origin in this country definitely fixed

History furnishes but little information concerning the cultivation of drugs in this country prior to the beginning of the nineteenth century In 1781 we find that Marshall attempted the cultivation of the opium poppy. In passing it might be stated that the cultivation of this plant is not difficult. It has been found to thrive in various parts of the United States and as far north as Vermont. A very fair quality of opium can be produced, but the amount of hand labor required is too great to enable us to compete with the Old World. We must wait for the production of our own morphine and codeine until we can derive it more directly from the plant. The United States Department of Agriculture has recently reported some progress in this direction.

The Shakers were the first people in this country to engage in what might be called extensive operations in drug cultivation They began it at Mount Lebanon, N. Y., as early as 1800, and soon established quite a business Other Shaker colonies subsequently took up the work, particularly at Union Valley, Ohio. One of these companies is said to have had at one time at least forty acres under cultivation. The annual production of drugs at Mount Lebanon when the industry was at its height is estimated at from 40,000 to 50,000 pounds. The work of the Shakers in this direction in recent times, particularly since 1880, has attracted but little attention.

One of the oldest medicinal plants in the world is mint. It was likewise one of the first to receive attention commercially in America. The production of oil of peppermint was begun in Wayne county, New York, in 1816, and soon reached sufficient importance to rate this county as one of the mint-producing

centers of the world. The cultivation extended to Michigan in 1835, and since then this state, owing to better soil and improved methods, has passed to the first rank. Mint growing is now a well-established industry in New York, Michigan and northern Indiana. The states Iowa, Wisconsin, Idaho, Oregon, Illinois, and quite recently Louisiana, contribute, but to a much lesser extent. It is believed that peppermint would do well on some of the rich bottom lands of Kansas. The profits to be derived from mint culture are said to be in the same class as alfalfa growing, but the market for the output is very much more limited and the industry could soon be overdone. The expense of planting, providing stills, etc., is also quite great. An acre of mint will produce from 12 to 50 pounds of oil, worth from $2 to $3 per pound

Ginseng, the first of our native drugs to be exported, and indeed about the only one still, was not one of the first to be cultivated Until about 1885 it was believed to be impossible of cultivation, though the suggestion of its cultivation was made as far back as 1801 by Samuel Stearns in his *American Herbal* The exportation of this drug is recorded in 1794, and official figures for 1821 show that 362,992 pounds were exported, averaging 48 cents per pound and valued at $171,586 In 1887 the average price per pound had risen to more than $2, yet its cultivation was regarded as doubtful and unprofitable by the United States Department of Agriculture

The first successful cultivation of this plant, according to an article by Forrest Crissey, published in *American Forestry* for 1913, is attributed to a Missourian, who inspired by the adverse reports of the Department of Agriculture, determined to "show the government" So successful was his demonstration that it is claimed that the returns from his little garden nine years later amounted to $25,000, and that shortly afterwards he was offered $100,000 for his ginseng patch of a quarter acre. A ginseng boom was started along about 1903, and, as was to be expected, a great many people lost all that they put into this venture Others more skillful and persistent had made it pay. Most of the supply of this drug is exported to China. The statements frequently quoted that it is of value only because of the fancied resemblance to the human form do not appear to be founded on fact, judging from the type of drug most in demand, which is the plain, finely wrinkled root that would be chosen by any drug expert as possessing the greatest medicinal value. This drug is now successfully cultivated in several states of the Union. Owing to its high price, the supply of the wild drug is practically exhausted. The tonnage exported has fluctuatingly decreased almost from the beginning, but the price, on the other hand, has increased more than proportionately. The records show that the largest exportation was 640,967 pounds, in 1841; the smallest 37,491 pounds, in 1854. The lowest average price per pound was 30 cents, in 1825, and the highest $8.16, in 1914. The total number of pounds exported in 1914 was 224,605, valued at $1,832,682. This, by the way, is the record in total value as well as in price per pound. In recent years disease has attacked the gardens to such an extent as to demand expert treatment. This has rendered the commercial cultivation of this plant more highly specialized and the monetary returns more uncertain than ever before. The long time required to mature a crop—five to six years—together with the appearance of disease, seems certain to restrict the cultivation of this plant in the future to those who are greatly interested in and thoroughly qualified for the work. This will tend to prevent overproduction, and in a measure maintain the con-

tinued high price, thus insuring to these few adequate financial returns for their labors.

Many of those of the less fortunate ginseng growers are already turning their attention to the cultivation of another and much hardier plant, hydrastis, or golden seal, which requires about the same general treatment. Golden seal also requires four or five years in which to mature a crop. The supply of this drug is limited at present to the wild plants, which are found growing chiefly in the valley of the Ohio river. The bulk of these plants are now literally eradicated. The price of this drug, which in 1895 was only 15 cents per pound, has now for several years ranged between $4 and $5. Those who are possessed of producing gardens are reaping a rich harvest. There is no question whatever in medical circles concerning the therapeutic value of golden seal. The market, though still largely a home one, is gradually extending to Europe. The danger of overproduction is not immediate, and it would therefore seem that for those who possess limited acres but limitless patience, and who are living in localities where the natural conditions of climate and soil are favorable, the cultivation of this drug offers a remunerative field.

Two other native drug plants of worth which are also becoming quite scarce are senega and cascara sagrada. Unless we are able to find substitutes for them their cultivation will soon become imperative.

The United States Department of Agriculture has in recent years been devoting considerable time and attention to the cultivation of medicinal plants, and in particular to those plants for which we are dependent upon other nations. One of the first of these to receive the attention of the department was the camphor tree. Camphor, though widely known and used, is only about two-thirds the commercial importance of ginseng The imports in 1914 amounted to 4,043,014 pounds, worth $1,112,505. It is said that about two-thirds of the amount imported is consumed in the manufacture of celluloid. The world's supply of camphor is obtained from China and Japan. During the Russian-Japanese War the supply of camphor became so uncertain and the price so high as to seriously interfere with the celluloid industry. This resulted in the stimulation of the production of synthetic camphor, and also in causing the United States Department of Agriculture to advocate the cultivation of the camphor tree in this country, especially in Florida and southern California. The department has been very successful in its experiments as well as in engaging private capital in this enterprise. There are now quite extensive plantations in Florida and also in the island of Jamaica. More economical methods of harvest than those used in the Orient have been employed, and the present indications are that we will soon be producing camphor in sufficient amounts for our needs. It is recommended that the trees be planted in a kind of hedge, so that they can be trimmed by machines once or twice a year. The camphor is obtained by distilling the leaves and twigs, which are found to be richer in oil and "gum" than the wood, and, of course, this method, unlike the Oriental method, is not destructive to the trees. There are now more than eighteen square miles of camphor plantations in Florida.

Other well-known drugs for which we have until quite recently depended entirely upon other countries for our supply are belladonna, hyoscyamus, digitalis and cannabis. These are now being successfully grown in the United States, though still in very limited quantities.

The introduction of belladona culture is due to Dr. F. B. Kilmer, of the firm of Johnson & Johnson, famous for belladonna plasters. The experiments were begun in the Belleview gardens of Mr. R. W. Johnson, president of the firm, in 1899. Since then its cultivation has extended into several states. The most elaborate experiments, perhaps, have been those conducted in California under the direction of Prof. Albert Schneider, of the California College of Pharmacy. The annual demand for this drug is estimated at between 300 and 400 tons. The average yearly yield per acre is variously stated, but a safe average would undoubtedly be about one ton. It will thus be readily seen that between 300 and 400 acres is all the territory that we need devote to this industry. This acreage will undoubtedly soon be under cultivation. Concerning the financial returns to be derived from the cultivation of this drug, it is stated that the first few pounds of it raised cost the firm of Johnson & Johnson more than $1,000 each. The market price of the drug is now about $1.75 per pound. One advertiser claims to have received $2,400 per acre for his crop.

Our nation recently experienced a marked shortage in digitalis, which for a time threatened to be serious. The school of pharmacy of the University of Minnesota has for several years been especially active in the propagation of digitalis, and when the shortage began to be felt this university announced that it had enough of the drug on hand to meet the needs of the people of Minnesota. The United States government called upon this institution for digitalis, and it in turn called upon other institutions for aid. The school of pharmacy and the peoples of the states of Oregon and Washington responded and collected quantities of this drug, which thrives without cultivation in the ranges near the Pacific in a strip of territory about forty miles wide and ranging from northern California through Oregon and well up into Washington. The school of pharmacy at Cornwallis forwarded to the receiving and testing station at the University of Minnesota some 1,600 pounds of choice dried drug, while from another small district in the state some 15 tons of it were collected. It is estimated that the Oregon territory alone can furnish 50 tons of digitalis annually, and of as good or better quality than that received in recent years from gardens in England. The annual import of this drug is claimed to be between 40,000 and 60,000 pounds.

By taking into account our various natural resources, it would seem that with a minimum amount of attention the greater part of our requirements in the way of vegetable drugs could in the future be easily taken care of through home production. Some steps in this direction have already been taken and a movement has been started to establish an institute for coöperative research as an aid to the American drug industry.

At the present time the cultivation and propagation of medicinal plants in the United States is being carried on in a more or less unorganized way by the following:

1. Manufacturers of drug products, such as the firms of Johnson & Johnson, New Brunswick, N. J.; H. K. Mulford & Co., Philadelphia, Pa., and Eli Lilly & Co., Indianapolis, Ind. The first-mentioned firm may be considered as the pioneer. This firm has devoted its efforts particularly to the cultivation of belladonna. The other firms have undertaken a wider field and have also achieved measurable success.

2. Botanical gardens, such as the Botanical Garden of New York, the Shaw

Botanical Gardens of St. Louis, the Philadelphia Botanic Gardens, and the gardens of the United States Department of Agriculture. The Department of Agriculture, through the Bureau of Plant Industry, has done and is doing a great amount of experimental work in the growing of economic plants in general, a goodly number of which are medicinal.

3. Various schools of pharmacy. Many of these have seriously engaged in the cultivation, and especially the propagation, of medicinal plants, and several of them have made considerable progress. Conspicuous in this group are the state schools of Michigan, Wisconsin, Minnesota and Nebraska.

4. Various seed and nursery firms.

5. Private gardeners, representing varying amounts of capital in the different states.

Though Professor Sayre was one of the first to advocate drug propagation as an essential part of the work of a school of pharmacy, Kansas has been slow to respond and has not taken a prominent part in this work Some financial assistance has at last been granted, and he hopes to begin some of this work in the very near future.

A review of the flora of Kansas discloses that there are growing within the borders of the state between 300 and 400 plants to which medicinal properties have been attributed. In this list there are but few species of recognized importance, and practically none of these are found growing in sufficient abundance to be of commercial importance to the state.

So far as I have been able to ascertain, ginseng is the only drug not native to the state that has been cultivated here, and that with indifferent success. Of the native plants the one of greatest importance is the echinacea, the natural range of which centers in Kansas and Nebraska. This drug is a very popular alterative, and many physicians, in spite of the adverse reports concerning its medicinal value from the laboratory of the American Medical Association, continue to prescribe it with gratifying results. The cultivation of this plant is recommended if the supply is to be maintained. It is quoted at 24 cents per pound. Whether its cultivation will prove remunerative at that figure remains to be proven. The proper place for settling this question would certainly seem to be in Kansas or Nebraska. Silphium—rosin weed—is another drug which is supplied to some extent from Kansas. It is quoted at 4 cents per pound for the root. There are several drugs that grow so persistently here that it would seem that their cultivation might be profitable. One of these is dandelion, which is quoted at 21 cents per pound. There are many other and more valuable exotic drugs which might flourish in Kansas were they but once introduced.

While it is believed by many that drug cultivation, on the whole, will not prove to be any more profitable than the growing of other field and garden products, this is no excuse for neglecting to produce so important an article. By improving the species and methods of harvesting, which has been done in almost every instance in which the subject has received attention, much may be accomplished in the way of discouraging foreign competition and increasing the financial returns. Attention should also be paid by the pharmacist and chemist to the preparation of drug concentrates, which, as in the case of such drugs as dandelion, would undoubtedly yield valuable returns and bring the drug itself into a more useful and favorable condition for therapeutic employment.

This entire field should and must be covered. It is almost entirely unexplored at present, and surely it presents an inviting opportunity for research to those who love to grow plants. We should, if for nothing more than as a matter of duty, take up this work seriously in the very near future and produce for our own use such drug plants as can be grown in our ranges of climate.

Many of the older members of this Academy have in times past displayed considerable interest in this subject, though in recent years we have heard but little from them concerning it. I wish to take this opportunity to invite them to continue this work and also to invite the younger members of the Academy to give it careful consideration, in the hope that before another quarter of a century rolls around Kansas, through her Academy of Science, will have been placed on the map.

In concluding, a series of lantern slides illustrating certain phases of this work were shown.

Patent Laws in Regard to the Protection of Chemical Industry.

L. E. SAYRE.

At the time of the last meeting of this Academy chemical manufacturers and many captains of our industries were facing a serious problem of supplies due to war conditions. The situation brought into prominence some questions relating to our patent and copyright laws which had a more or less direct influence upon the stimulation of home production, self-dependence, the stimulation of invention, research, etc. Our laws with reference to this subject, it was believed, needed revision. A rather informal discussion of this subject took place at our annual meeting, which suggested the presentation of the present paper in the hope that, now the war is over, the subject may be still kept alive and some deliberate legislation may be finally obtained which will tend to further the aim above referred to.

There are at least two distinct methods our government has recognized to promote research and invention; one is by subsidy, and the other by patent, trade-mark laws, etc. As a recent example of subsidy, we may cite the appropriations made by Congress for experimental purposes. From the *Congressional Record* we note that for aviation purposes the third session of the Sixty-first Congress, 1911, appropriated $25,000, and in the second session of the Sixty-second Congress, 1912, $20,000; the Sixty-third Congress, 1914, $10,000. Since the first session of the Sixty-fourth Congress, there was appropriated from public funds for aviation purposes over $50,000,000, a large part of which may be considered as subsidy for research and invention.[1]

In every age progress has been obstructed and the beneficient work of inventors set back for a generation by the general apathy and the utter lack of public encouragement and recognition. Who can estimate the incalculable public advantage, the benefits redounding to the general welfare, to industrial progress and the steady advance of science and the arts had the government promptly and generously assisted, by subsidy, in the development and promotion of such epochal inventions as the spinning jenny (1769), the power

1. *Congressional Record*, vol. LV, p. 5129.

loom (1785), the locomotive (1786), gas lighting (1792), cotton gin (1793), steamboat (1796), the reaper (1831), rubber goods (1830-1840), sewing machine (1843), submarine (1878), telephone (1876), airship (1903), etc.

The laws pertaining to patents—the other method of stimulating invention—are too well known to need description, yet the rules relating to them are elaborate and complicated.

These laws might be considered, perhaps, as an indirect method of subsidy; they have been, undoubtedly, in spite of their abuse, a great stimulus to scientific and inventive activity and of much importance in the proper protection of our chemical industries

W. B. Munro, in his volume, "The Government of the United States," page 283-284, in defining these laws briefly, says:

"Congress is given the power to 'promote the progress of science and the useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries'; in other words, to grant patents and copyrights."

"A patent is a certificate given to an inventor, securing for him during a designated term of years the exclusive right to make such profits as there may be in his invention. . . ."

"Trade-marks have no necessary relation to inventions or discoveries, and do not come within the power to issue patents or copyrights. But the trade-mark used in interstate commerce may be registered in the patent office. When intended for use in trade within a single state they can be protected only by state registration."

"It should be mentioned, moreover, that the granting of a patent does not give an inventor the right to manufacture or to sell his invention except under such conditions as the police power of the states may impose. Even patented articles, if dangerous to safety, health or morals of the community, may be excluded by the laws of any state The imposition of a license fee by the states for the sale of any article, moreover, would apply as well to patented merchandise as to any other. The right to manufacture or sell is not derived from the patent, and is neither increased nor diminished thereby."

To the physician, pharmacist and chemist, who are familiar with the various types of patented and trade-marked proprietary articles, it seems clear that some reforms are necessary—reforms tending to eliminate unjust discriminations that favor foreign countries, permitting them to utilize our patent and trade-mark laws for building up foreign industries at the expense of our own, and the American people. A protest against this situation has been put forward by several writers. Mr. J. W. England, for example, of the American Pharmaceutical Association,[2] finds the crux of the situation in our system of "product protection." He says:

"The crux of the situation with reference to the patent protection of chemical compounds, more particularly the synthetics, in this country, is to be found in our system of product protection. We not only permit the copyrighting of the title of a chemical compound and the patenting of the process for making it, but—and this is the vital point—we permit the first inventor to patent the product *as such*, and thereby estop all future inventors from marketing the same product, no matter how made.

"It is hardly necessary at this time to cite examples of the thousands of synthetical compounds that are made in Germany and process-patented and product-patented in this country; but, for illustration, we shall call one of these 'X'—and it is a widely used compound. Prior to the European conflict 'X' sold in this country for about 40 or 50 cents an ounce (wholesale), while

2. Jour. Amer. Pharm. Assoc., vol. VI, No. 2; Feb. 1917.

the price in London was equivalent to about 8 or 10 cents an ounce. Therefore, the product protection of chemical compounds *prevents the growth and devolopment of an American industry.*

"'X' cannot be marketed and sold in this country except by the owners of the patent, who have product-patented the compound, even if it be made by an entirely new and original process of manufacture and the process has been patented; this has been decided by the Federal courts.

"But in Germany, for example, 'product patents' are not recognized, and 'X' can be made by any other process than that used originally for making it, and can be marketed.

"Under the United States patent laws no one but the owners of 'X' can market and sell it in this country, and as these owners alone have the monopoly of sale, they can fix the selling price. American manufacturers generally might make this compound by new and original process, but under the consistent rulings of our courts they could not sell the product they made in this country; they could make and sell it in Germany."

From the foregoing it would seem that from the standpoint of the scientist the laws are to be, perhaps, criticised as tending to grant so exclusive a monopoly that further research in the same line is discouraged.

Mr. England suggests six different changes and modifications for the betterment of our patent laws, among the number being that "the Commissioner of Patents should be authorized to 'suspend' the life of a 'product patent' if it can be demonstrated that the product can be made by an entirely new and original process, and it might be desirable to provide, also, that the inventor of the new process shall pay the original inventor an equitable royalty (to be determined by the Commissioner of Patents) so long as the 'life' of the process patent of the original invention lasts. In this way the original inventor could lose no property rights if he has any."

He further suggests that which the writer has learned from those who are quite familiar with the business of the United States Patent Office to be very important (and has been suggested by experts), that "when the issues of a patent case bear upon technical or scientific knowledge and judgment, as do many patent cases, the law should provide a method, both for legal and administrative work, whereby a technical expert or referee or board of referees could be called upon to examine the evidence and report findings of facts, at the expense of the Federal government. The government employs lawyers to pass upon technical questions of law. Why should it not employ technical referees to assist the court to pass judgment upon questions beyond the ability of court and jury to properly understand? If this were done, the technical and scientific defects of patent legislation would be disclosed and remedial measures could be readily adopted. The determination of patent questions is a technical and scientific matter, and the greatest obstacle in the way of patent reform is the ignorance of the legal fraternity, including both the bench and the bar, in the sciences of medicine, pharmacy and chemistry and the arts or technical applications of the same."

This need for patent-law revision and scientific investigation of claims was forcibly presented in a pamphlet published by the American Medical Association in a report of the council of pharmacy and chemistry which referred to letters patent granted for a medicinal preparation May 2, 1916, which preparation was shown to be inactive and which did not have the merit that was claimed for it as a therapeutic agent. In this report the following language is used:

"The council has continued its study of the United States patent law as it

applies to medicine, and has become convinced that in many instances the patent law or its enforcement is contrary to the best interest of the public, both as concerns health and prosperity. The council feels it a duty at this time to protest against the provisions of our patent law, or the methods of its enforcement, which permit the granting of patents without thorough and scientific investigation of the claims advanced in such letters patent."

Few students are better informed as regards those phases of the patent and trade-mark laws which relate to chemistry, pharmacy and medicine than Dr. F. E. Stewart, of Philadelphia. His comments on the Paige bill,[3] which proposed to revise the laws and meet the obvious objections of the present law, are published in the proceedings of the American Pharmaceutical Association, February, 1917. His writings have received favorable comment even from able patent attorneys. It would exceed the limits of this paper to give even a brief review of his comments.

"The Paige bill," he says, "is intended to limit the patenting of certain chemicals mentioned in the bill to processes for their manufacture, leaving the products themselves open to competition, so that others may be stimulated to invent new processes whereby said chemicals may be produced of a better quality or at a lower price during the lifetime of the patent. In other words, no monopoly of the products themselves is permitted, the only monopoly being processes governed by patents." He refers to the course other countries have pursued in relation to product patents in this connection

"Medicines are excluded from patent protection in Germany, France, Austria-Hungary, Italy, Japan, Denmark, Norway, Sweden, Portugal, Russia and a number of other countries. Other classes of inventions excluded from patent protection in many countries, as well as in Germany, are foods, chemical products, and inventions relating to war material. In all of these countries exclusion from protection of inventions relating to medicines or foods does not generally extend to those relating to processes or apparatus for their manufacture. In all foreign countries which exclude chemical products from protection, except Switzerland, inventions relating to chemical processes may be patented, and in nearly all such countries it is expressly provided by law that a patent for a chemical process by which a new chemical product is made shall in effect cover such product, unless it be shown that such product was made in fact by some other process In other words, when a new product is discovered, and a process of manufacture is patented, no person is permitted to compete with the original patentee unless he is able to show that the process he is to employ for that purpose is not an infringement upon the patented process. The German patent law excepts from patent protection (1) inventions the application of which is contrary to the laws or public morals; (2) inventions relating to articles of foods, whether for nourishment or for enjoyment, and medicines, as also substances prepared by chemical processes, in so far as the inventions do not relate to a definite process for the preparation thereof. Patents are granted, however; for processes and apparatus for manufacture, and section 35 provides a method for protecting inventors of processes for the production of new substances in the following manner· 'If the invention relates to a process for the production of a new substance, all substances of like nature are considered as having been made by the patented process until proof to the contrary is given.'

"The Paige bill seeks to remedy one serious objection to our patent law by making it necessary for foreign patentees to manufacture their products in this country within two years after the patents have been granted. . . . Product patents have been granted by the United States to foreign manufacturers without insisting that the manufacture of such products shall be carried on in this country."

3. Bill known as H. B. 11967, a bill to amend sections 4886 and 4887 of the Revised Statutes relating to patents.

This being the case, Doctor Stewart says:

"It becomes evident that our patent law as now interpreted and applied does not promote progress in the arts of chemistry, pharmacy and drug therapeutics as carried on in the United States; in fact, it is very serious hindrance both to science and to the arts referred to. It hinders science because it does not stimulate original research on the part of would-be inventors in this country. Neither does it build up United States industries."

The writer has endeavored to find out the fate of the Paige bill. He understood that it had been locked up in the committee and has not yet been taken out A letter received from a large manufacturer, dated April 4, 1919, says:

"The most we can say of the Paige bill and all others before the Sixty-fifth Congress, not passed, died with that body on the fourth of March last. The slate is therefore absolutely clean What will be introduced in the next Congress no one can, of course, foresee, but the excuse that legislation that will discriminate against American chemists and pharmacists is needed to protect the public against the rapacity of the German owners of certain synthetic products no longer exists. In the opinion of the American Drug Manufacturers' Association, which met at New York last week, no amendment to the present substantive patent law is needed; but a patent court should be provided with country-wide jurisdiction to correct the present conflict between decisions in districts and circuits of limited territorial jurisdiction."

It has been urged before the Commission on Patents, says Doctor Stewart, that—

"The United States patent law should be amended to exclude from patent protection both medicines and chemical products generally, at least in so far as such inventions are the inventions of subjects or citizens of the foreign countries which exclude this class of inventions from patent protection, and it was contended then, and has been the contention ever since, that subjects or citizens of foreign countries should not be allowed to receive in this country patents for inventions which are not patentable in their own country Thus far the German manufacturing houses have been able to defeat this very desirable legislation It has been argued that certain treaties between the United States and Germany which give us certain advantages will have to be abrogated to permit such a change in the law. It would seem to me that this question of treaty should be carefully looked into by Congress for the purpose of ascertaining the truth in regard to the matter and for the purpose of publishing the truth, so that the American people may have an opportunity to decide whether or not we are gaining more than we are losing by such a treaty as the one urged as an excuse for not so revising the patent law as to protect American inventors from what appears to be such unfair competition. If the United States government should conclude to limit patents to processes only, surely something should be done to throw the burden of proof upon those claiming to have invented new processes for producing the same products as those produced by the patented processes."

This latter point we feel is well taken and should be one item for revision, namely: The inventor of a new process should be required to assume the burden of proof and establish the fact that his process is no infringement, and not throw this burden of proof on the original inventor.

If such wise procedure were adopted it would seem to indicate and emphasize what has been suggested—the advisability of some kind of advisory and coöperative board of scientists that would not only assist in solving such problems, but would materially aid in the aims and objects of those who create and administer patent and copyright laws.

We all know that before laws can be executed they must be enacted, and that before they are enacted they should be discussed and thoroughly in-

vestigated. Now all laws dealing with inventions and discoveries are executed by the Patent Office, enacted by Congress, and investigated thoroughly by nobody in particular.

To establish a commission to investigate matters of a highly scientific nature and to advise Congress is nothing more than doing what is now being done in the field of art We have established (May 17, 1910) a "National Commission of Fine Arts" to advise Congress regarding the building of national memorials and buildings. Members of Congress are not artists, and so seek the advice of these trained commissioners. Neither are the members of Congress scientists, and so should have such a body to refer to in order to promote the progress of science as well as the fine arts.

The multiplication of advisory boards and commissions is the subject of much criticism to-day We find ourselves afraid to establish one authoritative body, and we forget that we have established, under guise of "winning the war" a commission to investigate "Garabed", a "Naval Consulting Board" under the leadership of Thomas A Edison, and a "National Advisory Committee for Aeronautics," not to mention many other such bodies.

Now that the war is over, a centralization of these boards and commissions is needed, so that we will have one body to investigate and advise Congress—one body to promote the progress of science, encourage invention and give technical help to Congress for the revision of patent law.

Such a board would find many points other than those presented needing revision. There is need, for example, of correction in the line of advertised trade-marked and so-called protected "secret preparations" and "proprietaries." A clear distinction should be made, that everybody could understand, between a patented chemical, a "copyrighted" or trade-marked proprietary article, and "patent medicine," which latter title, in the eyes of the scientist, is extremely ludicrous.

In conclusion permit me to say that now the war is over, and many of the irritations in connection with the patent laws subsided, there is a chance that we lose interest in this important subject. While public sentiment may do much, in spite of inefficient laws, to correct unfairness and abuse, little can be hoped for until wise revisions are perfected. The incentive in presenting the present paper has been coupled with the hope that the subject may be kept alive and agitated and that the interest in it may be widened.

Another concluding remark. Chemists in this country and Canada are now endeavoring to accomplish through subsidy what is fundamentally the aim of our patent laws. Canada is considering the formation of a guild, which will be properly supported, for the purpose of carrying on research of interest to the trade. The American Chemical Society is proposing a national institute for drug research as one of its objects, which will aim to acquire more definite knowledge of the action of drugs upon the human body. The society is asking for a fund of $10,000,000 for its scheme. The American Pharmaceutical Association is likewise proposing to enter upon this important field of investigation of medicinal chemicals. It is fair to assume that the future looks very promising, since so much interest is now being taken in this general subject of research and investigation.

Some Dragon Flies of Southeastern Kansas.*

VERNON C. ALLISON.

The dragon flies described in this paper were all caught within a radius of two and one-half miles of the Kansas State Manual Training Normal campus. The localities visited were Playter's lake; the strip pits just west of the Fairview dairy barn; Cow creek and the pasture this side on west Quincy; the strip pits west of Cow creek on the north side of Quincy, and on Cow creek near the Missouri Pacific bridge. A few were caught near the Missouri Pacific bridge over Second Cow creek.

Thirty-four species were collected and classified during the years 1913, 1914 and 1915, and the list of dragon flies in this neighborhood is not yet complete.

They begin to appear in this section about the first of May, in the following order. *Plathemis lydia, Libellula basalis, Celethemis elisa* (the males quite awhile before the females), *Tramea lacerata, Pantala hymeneæ, Pantala flavescns, Tramea onusta, Anax junius, Pachydiplax longipennis,* etc. The Agrionidæ and *Dromogomphus spoliatus* become common about the middle of July, the Æschinæ in August and the *Pantala* in late August and early September. The *Sympetrum* does not appear until late August and are present in great numbers during the month of September.

The early dragon flies decrease about the middle of July, but a second crop appears the latter part of the month. A great number of tenerals may be observed at this time. The latter part of August witnesses the final decrease of the early dragon flies—Libellulidæ, etc.

With the exception of the *Tramea*, rain drives the dragon flies to shelter. They seek shelter according to the following order: *Libellula basalis, Plathemis lydia, Pachydiplax longipennis, Perithemis domitia, Epicordula princeps, Libellula auripennis. Mesothemis simplicollis, Anax junius.* The *Trameas* seem actually to increase their activity during a rainstorm of twenty minutes or less. On misty days the *Pantala* gather in large numbers in small clearings between the trees. A rain the night before or a heavy dew delays the morning appearance of the dragon flies for several hours.

Wind forces most of the dragon flies (the Agrionidæ especially) to the shelter of the grass, weeds and trees. A very few *Libellula basalis, Plathemis lydia, Perithemis domitia, Pachydiplax longipennis* and *Libellula auripennis* brave the wind. The *Tramea* and *Pantala* fly much higher on slightly windy days.

The heated part of the day compels most of them to the shade, although a few listless ones stay out in the sun.

The *Planthemis lydia, Libellula basalis, Libellula pulchela* and *Pachydiplax longipennis* fly from 8:30 a. m. to dark, while the others fly from 8:30 or 9:00 a. m. to 11 a. m. and from about 4 p. m. till dark.

The *Æschna pentacantha* will make short flights of about fifteen or twenty minutes' duration out over the fields, returning at the end of the period to a favored spot (the same spot each time), generally a shaded birch leaf overhanging the water. They appear to go to "roost" about 5:30 p. m.

* "The Insect Book," Howard; Hagen's "Neuroptera"; "The Dragon Flies of Indiana," by E. B. Williamson, were used in this work.

The *Dromogomphus spoliatus* patrol the bank until about 4 p. m., when they become more and more active, flying higher and farther away from the water.

Great swarms of *Anax junius* sometimes invade town about 7 30 p m, flying very low to catch the evening-flying diptera Such a swarm (about 1,000) was observed at the corner of Walnut and Euclid.

In the morning the dragon flies appear in the following order· *Epicordula princeps, Libellula auripennis, Libellula pulchela, Libellula basalis, Tramea onusta, Tramea lacerata, Perithemis domitia, Celethemis elisa, Pachydiplax longipennis, Mesothemis simplicollis,* and, lastly, *Anax junius*

The *Tramea* and *Pantala* are extremely hard to catch. They fly high, and the only way to catch them is to stand patiently out in the sun in a conspicuous place, and when their curiosity (common to all dragon flies) lures them down, catch them with a thirty-inch net on an eight-foot pole Coupled dragon flies, especially the Agrionodæ, are much more wary than the single ones.

Williamson (page 236) says "Red mites (*Acarina*) are frequently found on the under surface of the thorax or abdomen." He is speaking of dragon flies in general I have very rarely observed them except on the *Pachydiplax longipennis* and the *Tramea.* They are very common on the *Tramea lacerata* and *Tramea onusta,* accompanied by small black mites the same size

The wings of the female *Tramea onusta* are for some reason nearly always badly frayed. *Plathemis lydia* are sometimes found with the venation of the front wing pied around the triangle.

The *Tramea* have a peculiar habit of parading during copulation. From two to six coupled pairs will parade for hours, maintaining a fixed equal distance between each couple. Once in a while a pair will alight on a leaf high up from the ground and remain several minutes.

The low-flying Libellulidæ are frequently captured by flickers I have, however, seen swallows and martins repeatedly fail to get the high-flying *Tramea* and *Epicordula princeps.* The *Tramea* or *Epicordula princeps* would wait until the bird was very close and shoot up with extreme rapidity, about two feet, and allow the oncoming swallow or martin to pass beneath them. The dragon fly would then calmly await another attack.

Fishermen claim that the female Libellulidæ are often caught, while ovipositing, by bass. I have seen the bass attempt it several times but fail each time.

Dragon flies, even *Anax junius,* with their powerful side-cutting mouth parts, can make no impression on the tough body of the large wasps. The Agrionidæ are sometimes caught in spider webs. The male *Mesothemis simplicollis* is in the habit of attacking and eating the *Perithemis domitia.*

The male *Ischnura verticalis* does not seem to use (or have) hooks on the superior end of his abdomen to seize the superior organs of the female during copulation, as other species do. He uses the tibiæ of his hind legs instead.

All authors on dragon flies remark upon the exceptional voracity of the dragon flies. Every dragon fly will eat any other dragon fly or insect that it can overcome. Williamson tells of a large dragon fly that was chloroformed and pinned down through the thorax. On coming to it started to struggle, but remained quiet as long as it was fed. A large dragon fly ate forty mosquitoes

in an hour. I have held a dragon fly by the wings and presented the outer end of its abdomen to its mouth. It ate the outer three segments of its own abdomen without a struggle. Any one or all four wings may be removed, even down to a distance of 1 mm. from its body, and the dragon fly makes no struggle as long as it is fed. It may be that they do not feel pain or that they are unable to localize pain.

Some dragon flies, especially some of the Libellulidæ, seem to parole a regular beat on a regular schedule, inspecting everything in their path. All dragon flies, with the exception of *Perithemis domitia,* are very curious. They are the fastest flying of all known forms of life, and also maneuver very quickly. They catch their prey on the wing, seizing it with their front legs and eating it while in the air.

The almost filled-up strip pit on the north side of Quincy, about 200 yards west of the Fairview dairy barn, seems to be monopolized by the *Libellula pulchela.*

The thirty-four species classified follow

1 *Æschna pentacantha* Rare Around water in shade West Quincy
2 *Æschna verticalis* Not rare West of Cow creek, on Quincy
3 *Anomalagrion hastatum* Not common Playter's lake
4. *Anax junius.* Common Water, pastures, etc
5 *Argia apicallis* Common Low-growing water plants.
6 *Argia putridia* Common Low-growing water plants.
7 *Argia violacea.* Common Low-growing water plants
8 *Celethemis elisa* Common Water, roads, pastures, etc
9. *Celethemis eponina* Very rare Smith's pasture, West Quincy
10 *Dromogomphus spoliatus* Common Weeds along still water, Playter's.
11 *Enallagma aspersum* Common Low-growing water plants.
12 *Enallagma civile* Common Low-growing water plants
13 *Enallagma signatum.* Common Low-growing water plants.
14 *Epicordula princeps* Common Pastures, still water
15 *Ischnura verticalis* Common Low water plants
16 *Lestes unguiculatus.* Not common Still water.
17 *Libellula auripennis.* Fairly common Still water
18. *Libellula basalis* Very common Roads, pastures, lakes.
19. *Libellula cyanea* Not common. Still water.
20. *Libellula pulchella.* Common Water
21. *Libellula vibrans* Not common Still water
22 *Macromia taeniolata.* Not common Running water
23. *Mesothemis simplicollis* Common Water
24. *Pachydiplax longipennis* Common Water, birch trees
25. *Pantala hymenæa.* Common Pastures, still water.
26. *Pantala flavescens* Common Pastures, still water.
27. *Perithemis domitia.* Common Low water plants
28 *Plathemis lydia.* Very common every place.
29. *Sympetrum albifrons.* Fairly common Pastures.
30 *Sympetrum corruptum* Fairly common Pastures.
31. *Sympetrum vicinum.* Fairly common. Pastures.
32. *Sympetrum semicinctum.* Fairly common. Pastures.
33. *Tramea lacerata.* Fairly common. Pastures, water.
34. *Tramea onusta* Fairly common. Pastures, water.

ORDER ODONATA.

SUBORDER ANISOPTERA. Wings horizontally extended when at rest.
SUBORDER ZYGOPTERA. Wings folded when at rest.

SUBORDER ANISOPTERA.

FAMILY ÆSCHNIDÆ. Cross veins between first and second longitudinal veins do not correspond to the cross veins between the second and third longitudinal veins. Triangle of the front wing generally of the same shape as the triangle of the hind wing.

Subfamily CORDULEGASTERINÆ. Eyes meet at a single point on top of the head, or barely separated.

Subfamily GOMPHINÆ Eyes separated at least the width of the apical wing spot—generally more.

Subfamily ÆSCHINÆ. Eyes meet on top of head for some distance.

FAMILY LIBELLULIDÆ. Cross veins between the first and second longitudinal veins generally correspond to the cross veins between the second and third longitudinal veins (exception of the first cross vein and one other). The long axis of the front wing triangle (vertical) is at right angles to the long axis of the hind wing (horizontal).

Subfamily CORDULINÆ. Small tubercles behind the eyes. Anal margin of the hind wings is excavated.

Subfamily LIBELLULINÆ. Eyes without tubercles. Anal margin of the hind wings not excavated

SUBORDER ZYGOPTERA.

FAMILY AGRIONIDÆ.

Subfamily CALOPTERYGINÆ. More than two cross veins between the first and second longitudinal veins between the base of the wing and the nodus (the nodus is the meeting place of the longitudinal veins between the tip of the wing and the base).

Subfamily AGRIONINÆ. Only two cross veins between the first and second longitudinal veins between the base of the wing and the nodus.

COLOR KEY.

Following is a color key which may be of some service in classifying these dragon flies.

SUBORDER ANISOPTERA. Wings horizontally extended when at rest.

BLACK OR DARK BROWN

Medium size. Basal one-third wings black. Female, apices wings tinged brown *Libellula basalis*

Medium to large. Three large black spots on wing. Female, *triangle in front wings colored to some extent* . . .. *Libellula pulchella*

Medium Small inner and large outer spot, black Female similar to female *L pulchella,* but smaller. *Triangle in front wings entirely uncolored* . . ....*Plathemis lydia.*

Medium to large. Ragged black spot at base of wing . ... *Tramea lacerata.*

Large. Similar to *L. pulchella.* Throax large, giving body club-shaped appearance *Epicordula princeps.*

Medium to large. Small chocolate brown spot at base, at nodus, and at tip of wings Apical spots bicolored. . . . .*Libellula cyanea.*

BLACK AND WHITE

Medium to large. Old males of the following species have the abdomen and those parts of the wings not black, chalky white......... .. ..*Libellula basalis.*
Libellula pulchella.

Medium. Old males have abdomen (but not wings) chalky white. . . *Plathemis lydia.*

BLUE AND GREEN.

Small. Greenish face. Old males gray-blue, chalky.. ....*Pachydiplax longipennis*

Very large. Male, green and blue. Female, green and purplish brown..... *Anax junius.*

Medium. Male, green and black or (old) chalky. Female, green and dark brown. *Mesothemis simplicollis.*

Very large. Bronze green and yellow. Large yellow band encircling thorax between front and hind wings......... . ...*Macromia tæniolata.*

Medium to large. Old male blue, chalky. Apical spots bicolored....*Libellula cyanea.*

RED, REDDISH-BROWN AND YELLOW.

Medium Reddish brown Brown spot at base of hind wings . . *Pantala hymenœa.*
Medium Yellowish. Yellow tinge at base of hind wings. .... *Pantala flavescens.*
Small Yellow or red, marked with black Apical spots red . *Celethemis elisa.*
Very small Male, yellowish brown Wings entirely colored reddish yellow —First female
Yellowish brown Wings colored like male.—Second female
Yellowish brown Wings clear with brown spots ... *Perithemis domitia*
Medium Reddish brown Reddish brown basal area on hind wing *Tramea onusta*
Large Yellowish or reddish brown Wings entirely tinged with yellow or reddish *Libellula auripennis*
Large Greenish yellow marked with brown End of abdomen much enlarged and yellow *Dromogomphus spoliatus.*
Small Reddish yellow spotted with black. Light forehead *Sympetrum albifrons*
Small Yellow to red Wings yellowish at base . *Sympetrum vicinum*
Small Yellow to red Wings yellowish from base to nodus *Sympetrum semicinctum*
Medium Yellow to red Veins of wings yellowish red or brown *Sympetrum corruptum*
Very large Reddish brown marked with bright green *Æschna pentacantha*
Very large Reddish brown marked with green and blue *Æschna verticalis.*
Small to medium Yellow or red marked with black. Blotches on the wings *Celethemis eponina*
Medium to large Yellow and chocolate brown Apical spots bicolored *Libellula syanca.*
Large Yellow and reddish brown Apical spots bicolored. *Libellula vibrans.*

SUBORDER ZYGOPTERA Wings folded when at rest (*Lestes*, wings half-folded when at rest)

BLUE

Medium Mature female, head and thorax pale blue . *Argia putrida*
Small Male, blue Female, lighter blue *Enallagma aspersum.*
Small to medium Male, blue and black Female, duller—sometimes yellowish green *Enallagma civile*
Medium Male, pale blue or drab Female (adult), pale blue and (young), light brown *Argia apicalis*

VIOLET

Small to medium Male, violet Female, dull violet or brown *Argia violacea*

GRAY OR DRAB

Medium Male, grayish drab or dull light brown *Argia putrida*

BROWN.

Medium Young females, light brown . *Argia putrida*
Medium Young females, light brown . *Argia apicalis*
Medium Male, blackish brown, under parts, yellow Young females similar Old females, markings obscured *Lestes unguiculatus.*

YELLOW AND ORANGE

Small One female, orange and bronze black . . *Ischnura verticalis*
Medium Male, orange. Female, similar with some bluish *Enallagma signatum*
Small Apical spot displaced Male, orange and black One female similar to male, another with much black, including top of abdomen. . *Anomalagrion hastatum.*

GREEN

Male, green One female green .. . *Ischnura verticalis.*

DETAILED DESCRIPTION.

ANISOPTERA. Wings horizontally extended when at rest.

1. *Æschna pentacantha* Rambur (probably *aischros,* Gr., ugly; *pente,* Gr., five; *acantha,* Gr., a thorn). Both sexes, abdomen, 56 mm.; hind wing, 48 mm. Male and female reddish brown, marked with bright green; face green or brown. Thorax with broad green stripe on either side above, short, green stripe in front of shoulder, and two green or blue stripes on either side. Abdomen marked with green and blue spots and rings, constricted at segment 3. No T-spot on top of forehead.

Habits: From August to late in the fall they frequent the edges of woods close to pools or small streams. They rest on leaves and twigs in the middle of the day, becoming more active later in the day, flying out over the fields, returning about once in thirty minutes to some particular shady spot near the water. As darkness comes on, the resting periods become longer and longer until they cease flying altogether.

2. *Æschna verticalis* Hagen (*vertex,* Lat., highest point). Abdomen: male, 52 mm.; female, 53 mm. Hind wing: male, 45 mm.; female, 46 mm.

Male and female reddish brown, marked with green and blue. Thorax with a green stripe on either side above, wider towards the top; sometimes a short green stripe in front of the shoulder and two green or blue stripes on either side, the forward one most distinct. Abdomen with spots and rings of green and blue. Abdomen is more slender than in *Æschna constricta,* constricted at segment 3.

Habits: Somewhat similar to above From August on

3 *Anax junius* Drury (*anax,* Gr., a king; *junius,* a Latin proper name). Abdomen: male, 55 mm.; female, 54 mm. Hind wing: male, 51 mm.; female, 52 mm

Male Green marked with blue and brown; face green, forehead above with a dark spot, surrounded by yellow, the latter surrounded by a blue ring. Thorax green Abdomen with segment 1 and base of segment 2 green; segments 3 to 19 bright blue with a longitudinal interrupted brown band on top. Wings tinged with yellowish. Abdomen constricted at segment 3.

Female cimilar. Abdomen with blue of male replaced by purplish brown

Habits Piratical. Large flocks fly low at dusk to catch the low-flying diptera. Becomes common in June. About this time they are found pairing and ovipositing about every weedy pond. Williamson says (page 306): "They fly about in couples, then drop down on some bit of floating stuff, where they rest a moment or so, the female with her abdomen submerged as she deposits her eggs; then the pair rise and fly back and forth along the shores or over the water, coming to rest again near or at a distance from their former resting place." May on.

4. *Celethemis elisa* Hagen (proper name). Abdomen male, 21 mm. female, 19 mm. Hind wing. male, 26 mm.; female, 25 mm.

Male and female: Yellow or red, marked with deep brown or black. Thorax with a shoulder, two side and a middle-of-the-back stripe, more or less black. Abdomen black, with the backs of segments 3 to 7 and the sides of segments 1 to 6 red or yellow. Front wings with the top row of cross veins and some other cross veins edged with brown; a small spot above the triangle (often lacking) brown, rounded spot near the top longitudinal vein between the nodus and apical spot and the tip of the wing from the apical spot on, brown (female, extreme tip of wing colorless and clear). Hind wings similar; a large brown basal area extending beyond the triangle and running backward almost to the rear basal margin; this brown incloses a paler tawny area.

Habits: Females retiring; outer edge of plants which border streams. Males are found out in the open pastures, each perched on a low shrub 3 or 4 feet from the ground, sometimes on flowers or sumach, which harmonize with their coloring. Each individual is master of his particular preserve, and may be frequently seen to sally forth and seize a passing fly. Very quarrelsome among themselves, they are "the butt of Odonate society, for *Anax, Libellula* and *Celethemis eponina* are sure to pay it their disrespects whenever they spy it in passing." July to October.

5. *Celethemis eponina* Drury (*epona,* Lat., goddess of horses). Abdomen: male, 26 mm.; female, 24 mm. Hind wing: male, 33 mm.; female, 32 mm.

Male and female: Reddish brown and yellow. Thorax with a middle-of-the-back stripe and two side stripes, blackish. Abdomen black with yellow spots. Brownish spots on front wings as follows: a spot covering much of the triangle and lying above and between it and the body, a nodal band running from the front edge of the wing almost to the back edge, and a band of

similar width and length just inside the apical spot. Hind wings similarly marked: a spot extending from the base to and covering the triangle, a rounded spot behind this, a nodal band constricted at the middle, sometimes divided to form two spots. Extent of markings subject to considerable variation.

Habits: I captured only one specimen (the only one I saw). I caught a male on August 15, 1913, in Smith's pasture.

6. *Dromogomphus spoliatus* Hagen (*dromos*, Gr., flight; *gomphos*, Gr., wedged-shaped bolt; *spoliatus*, Lat., impoverished). Abdomen: male, 41 mm.; female, 43 mm. Hind wing. male, 34 mm.; female, 36 mm.

Male and female: Yellow or greenish yellow, marked with brown; face greenish. Thorax brown above. The following is yellow: a mid-cross stripe on top of the thorax, a collar on top, an oblique bar on either side, a narrow stripe (sometimes interrupted) in front of the shoulder. Sides of the thorax are generally a greenish yellow, with a brown stripe on each suture. The abdomen has segments 1 to 6 black or dark brown above, with irregular interrupted longitudinal stripes down the back and on each side yellow. Segments 7 to 9 are greatly dilated, yellow, clouded and shaded with brown; segment 10 is entirely yellow. Apical spot light brown. Front rib of the wing greenish. The abdominal appendages are entirely yellow.

Habits. Common over still water. Fly slowly but warily over the water, close to the shore, copulating and ovipositing until about 4 p.m., when they leave the vicinity of the water and fly out over the fields at a height of 20 to 30 feet Common from July on.

7. *Epicordula princeps* Hagen (*epi*, Gr., near to; *cordyle*, Gr., a club; *princeps*, Lat., a chief). Abdomen male, 43 mm.; female, 46 mm. Hind wing: male, 41 mm., female, 44 mm.

Male Olive or yellowish brown, obscurely marked with yellow. Thorax clothed with a very fine fuzz; markings obscured. Abdomen with yellow along the sides Wings with a basal, a nodal (this is sometimes wanting) and an apical spot, all variable in size, brown. The superior appendanges (the superior appendages are those at the outer end of the abdomen) are almost as long as segments 9 and 10 and the outer two-thirds are expanded; the inferior appendages are less than one-third shorter, long, triangular; apex with two upturned points.

Female similar. Appendages are as long as segments 9 and 10. The vulvar lamina are almost as long as 9, divided for their entire length and forked at the end.

Habits. Fairly common over still water. Strong and restless flyers. Easily distinguished from *Libellula pulchella*, which they resemble in wing markings, by the large size of their thorax in comparison with their abdomen, giving them a club-shaped appearance. June on.

8. *Libellula auripennis* Burmeister (*aureus*, Lat., golden; *penna*, Lat., a wing). Abdomen: male, 38 mm.; female, 36 mm. Hind wing: male, 40 mm.; female, 39 mm.

Male and female Yellow or reddish brown. Young individuals with a yellow mid-stripe down the back of the thorax. Abdomen with a black mid-stripe on top. Wings yellowish or reddish ("golden"), especially along the front margin; tips of the wings sometimes brown.

Habits: Rather wary. Fairly common about still water. July to October.

9. *Libellula basalis* Say (*basis*, Gr., base). Abdomen: male, 31 mm.; female, 27 mm. Hind wing: male, 40 mm.; female, 39 mm.

Male: Blackish brown. Abdomen yellow on both sides; this is obscure in older individuals. The basal one-third of the wings are dark brown or black, in older individuals chalky white. The basal black area on the front wings is darkest beyond the base.

Female: Wings with less black, sometimes only a dark tinge extending to the triangle, on the front wings no chalky white beyond the dark area; tips usually dark.

Habits: Very curious; stick their noses into everything; patrol a regular beat; easy to catch, frequently lighting on the net Very common from May to October, the first brood appearing in May and the second about the latter part of July.

10. *Libellula cyanea* Fabricius (*libella*, Lat, a water level, *cyaneos*, Gr., dark blue). Abdomen. male, 29 mm, female, 27 mm. Hind wing male, 35 mm.; female, 34 mm

Male and female. Chocolate brown and dull yellowish A brown mid-stripe on top of the abdomen. Thorax with yellow sides and a yellow mid-stripe on top. Basal streak in the front wings between the second and third longitudinal veins and a shorter one usually between the fourth and fifth longitudinal veins. Sometimes the tips of the wings are brown The bicolored apical spot is yellowish at either end. The older males become entirely chalky white and much resemble the older males of *Mesothemis simplicollis* except for the bicolored apical spot.

Habits. Around still water. Not common. June on

11. *Libellula pulchella* Drury (*pulchellus*, Lat, beautiful) Abdomen. male, 34 mm.; female, 32 mm Hind wing male and female, 42 mm.

Male and female Blackish brown Sides of thorax with two wide yellowish stripes Abdomen with yellow stripe on each side, chalky white in the older males. Wing spots black or dark brown, a basal spot between the first and second or the second and third longitudinal veins, extending to or beyond the triangle, covering the triangle completely in the hind wings, more or less in the front wings; a large nodal and a large spot at the tip of the wings Male usually with the back portion of the hind wing and spots alternating with the black spots on all the wings, chalky white

Habits. Swift fliers. Common about water. Sometimes a single specimen keeps a hunting preserve, driving off all others except *Anax junius* July to October.

12. *Libellula vibrans* Fabricius (*vibrans*, Lat, fluttering) Abdomen male, 40 mm.; female, 38 mm Hind wing male, 48 mm.; female, 47 mm.

Male and female Yellow and reddish brown. Yellow mid-stripe on top of thorax, and sides of the thorax yellow with slight blackish markings The sides of the abdomen are yellow The older males are chalky white, obscuring the markings. Wings There is a long black basal streak between the second and third longitudinal veins; tip of the wing black (especially in the female), and a black spot at the nodus

Habits. Not common. August on.

13. *Macromia tæniolata* Rambur (*tæniola*, Lat, a little band). Abdomen: male, 60 mm.; female, 62 mm. Hind wing male, 54 mm.; female, 58 mm.

Male: Brown and metallic green, marked with yellow; face brown. Crosswise yellow nose band. Thorax with a short yellow cross stripe on top and a broad yellow band entirely encircling the thorax between the front and the hind wings. Abdomen with an interrupted crosswise ring on segment 2, a divided spot on the tops of segments 2 to 8 (larger and usually united on 7), yellow. Wings tinged with yellowish.

Female similar, often lacking the yellow spot on segment 8 Wings more yellowish.

Habits: Rather uncommon. Running water. July to October.

14. *Mesothemis simplicollis* Say (*mesos*, Gr., middle; *themis*, Gr., the goddess of justice; *simplex*, Lat., simple; *collum*, Lat., neck). Abdomen: male, 30 mm.; female, 29 mm. Hind wing: both, 31 mm.

Male: Green and black; face green. Thorax green, sometimes sutures black. Abdomen mostly green basally, outer half mostly black. In older males the thorax and abdomen become entirely a chalky, grayish blue. Superior appendages whitish, toothed underneath.

Female: Green and dark brown, similar to the young male. Vulvar lamina are elevated, triangular, entire.

Habits. Female generally hidden in the weeds about water, feeding. Male is very active Williamson observed the male to eat butterflies (*pamphila*), moths and dragon flies (*Lestes vigilax* and *Argia violacea*). Several times I have seen a male seize and decapitate a *Perithemis domitia*. Because of his very rapid movements and radical change in coloring, (changing from green and black to a light grayish blue as he grows older), the old males are easily mistaken for members of entirely different species. June on.

15 *Pachydiplax longipennis* Burmeister (*longus*, Lat., long; *penna*, Lat., wing). Abdomen male, 24 mm., female, 22 mm Hind wing male, 29 mm.; female, 28 mm.

Male Young, face whitish or greenish, forehead and top of head metallic blue. Thorax dark brown, with several yellowish or greenish markings, including three broad stripes on sides. Abdomen black or brown with interrupted greenish stripes on top and sides In older males the thorax and abdomen become chalky, and the markings thus obscured Wings clear, sometimes tinged with brown, especially between the nodus and the apical spot, dull yellow at the base, hind wings sometimes with a short black streak lengthwise of the wing

Female Similar to young male, occasionally chalky in old individuals.

Habits Very common on water plants, apparently preferring birch trees as a resting place Sometimes carries parasites like those on the *Tramea* (Acarina) Males sometimes seen at a little distance from the water.

16 *Pantala hymenæa* Say (*hymenæus*, Lat., god of marriage) Abdomen male, 30 mm , female, 31 mm Hind wing male, 41 mm , female, 42 mm.

Male and female Reddish brown, marked with darker brown Abdomen banded and ringed Hind wing with the anal angle yellowish and with a round, dark, yellowish-brown spot, tips of the wings sometimes tinged with yellow.

Habits Fly during July and August, and are very difficult to capture. They move swiftly, sometimes at a considerable height (40 to 100 feet), apparently never alighting. I have succeeded in obtaining specimens only by standing for an hour or so in a conspicuous place, when they are apparently lured by curiosity within reach of a long net July on. This species is confined to North America

17. *Pantala flavescens* Fabricius (*pan*, Gr, all; *ala*, Lat, wing; *flavescens*, Lat., turning light yellow) Abdomen male, 32 mm., female, 33 mm. Hind wing male, 41 mm , female, 40 mm

Male and female Yellowish. Abdomen with a whitish mid-stripe on top, absent from some segments; sides of segments 1 to 8 are black The anal margin of the hind wings is yellowish, tips of the wings are sometimes tinged with yellow It is a cosmopolitan species.

Habits Same as *hymenæa* These two species comprise the genus. July on.

18 *Perithemis domitia* Drury (Latin proper name). Abdomen male, 14 mm ; female, 13 mm Hind wing male, 18 mm ; female, 19 mm.

Male Yellowish brown. Markings obscure. Thorax sometimes with two pale side stripes. Abdomen with some yellow marks. Wings a uniform tawny yellow, or sometimes with a brown spot near the triangle and a basal brown streak on the hind wings

Female· Wings clear; front wings tinged yellowish along the first longitudinal vein, a yellowish-brown spot or area bordered with yellow near the triangle and another and larger one at the nodus; hind wings similar, the inner colored area covering the triangle and extending backward toward the anal angle. These markings vary greatly. Males are sometimes found with the wings colored very much as in the female. I find a very common dimorphic female, in which the wings are clear, colorless and spotted with brown; the body coloring is the same as in the other female. (This form is illustrated in Howard's "Insect Book," but is not referred to by Williamson.)

Habits: Very timid and retiring, perching on low water plants. They are very much annoyed by the *Libellula* and by *Anax junius*. June on. The spotted-winged female appears about the middle of July.

19. *Plathemis lydia* Drury (a proper name). Abdomen: male, 28 mm.; female, 24 mm.; hind wing: both 33 mm.

Male and female: Brown. There are two yellow stripes on each side of the thorax. The older males have the thorax largely and the abdomen entirely chalky. The males have the wings marked as follows. a basal spot between the first or second and the fifth longitudinal veins, extending to the triangle in the front wings and to and covering the triangle in the hind wings; the basilar space is almost clear; a wide band for the entire width of the wing between the nodus and the apical spot. The above markings are dark brown or black. There is a chalky-white spot behind each basal spot, sometimes wanting in the front wings.

Female: Wing markings are much like *Libellula pulchella,* but the triangle of the front wing is entirely clear and untinged. The abdomen is heavier than that of the female *Libellula pulchella.*

Habits: Extremely curious and fearless. With *Libellula basalis,* they are the buttinskys of the Odonata Very common. Female retiring except when copulating or ovipositing Male suns himself except when patrolling or copulating. April to October. Our earliest and hardiest dragon fly. I have been told by fishermen that the large-mouth black bass often catches the ovipositing female, and have myself seen several attempts which were, however, unsuccessful

20. *Sympetrum albifrons* Charpentier (*sympedge,* Gr., to press together, *etrn,* Gr., the abdomen; *albus,* Lat., white; *frons,* Lat., front). Abdomen both 24 mm. Hind wing both 25 mm.

Male and female Reddish yellow. Abdomen red (adult) or yellow (young), spotted with black. The wings are yellow at the extreme base. The vulvar lamina are short, rounded and the apex is notched This and following species of *Sympetrum* are similar in coloring and can best be identified by the intromittent genital organs of the male, which differ markedly in the different species.

Habits Common August to November Still water, swampy ground and meadows.

21. *Sympetrum corruptum* Hagen (*corruptus,* Lat., marred or spoiled). Abdomen: male, 27 mm; female, 28 mm. Hind wing, male, 29 mm.; female 30 mm.

Male and female vary greatly in coloration at different stages.

Young. Thorax yellowish. Following markings grayish narrow shoulder stripe, stripe in front of the shoulder, and two side stripes terminated below by a bright yellow spot (later all these markings disappear except the two yellow side spots). The abdomen is yellowish; some black on the sides and above on segments 8 and 9.

The fully adult *corruptum* is red. Veins and apical spot yellowish and brown, or red. The legs are black, sharply lined with yellow.

Habits: Similar to above. August to November.

22. *Sympetrum semicinctum* Say (*semi,* Lat., half; *cinctus,* Lat., encircled). Abdomen: both 20 mm. Hind wing. both 23 mm.

Male and female: Coloration as in the other species, yellow to red, sides of the abdomen spotted with black. The front wings are yellowish brown from the base to the nodus or triangle. The hind wings are also yellowish brown from the base to the nodus, but are usually lighter at the base.

Habits and occurrence same as the above.

23. *Sympetrum vicinum* Hagen (*vicinus,* Lat., neighborly). Abdomen: male, 21 mm.; female, 22 mm. Hind wing: male, 24 mm.; female, 23 mm.

Male and female: Yellow to red (female sometimes brown). Black side markings on the abdomen. The wings are yellow at base only. The yellow on the wings is usually distinct.

Habits similar to the preceding. August, well into November.

24. *Tramea lacerata* Hagen (*trama,* Lat., spider's web; *lacertus,* Lat., torn). Abdomen: male, 36 mm.; female, 35 mm. Hind wing: male, 43 mm.; female, 44 mm.

Male and female: Brownish black. Top of abdomen with white or greenish spots, segment 7 usually conspicuously light colored, especially in the female. Front wings with a little brown at the base; hind wings with a large ragged black spot at the base; in tenerals (young, shiny, winged specimens) this is reddish or yellowish brown. The male superior abdominal appendages are as long as segments 8, 9 and 10. The vulvar lamina of the female are as long as segment 9 and bilobed.

Habits: In the morning, fairly common about water; in the afternoon and evening are found at some distance from water, flying high over dry pastures. Small red or black parasites (Acarina) are often found on the under side of the thorax and on the under side of the base of the front wings, as in *Pachydiplax longipennis*. Middle of June on.

25. *Tramea onusta* Hagen (*onusta*, Lat., burdened). Abdomen: male, 31 mm.; female, 33 mm. Hind wing: male, 40 mm., female, 42 mm.

Male and female: Reddish brown. Front wing tinged at base. Hind wing with a reddish-brown basal area, not so ragged as in the *lacerata*. Male superior abdominal appendages are a little longer than segments 9 and 10. The vulvar lamina of the female are as long as segment 9, and bilobed.

Habits: Very similar to the *lacerata*. Has a habit of parading during copulation. From two to six couples will parade a regular beat in single file, preserving a relatively fixed distance between each other. I have never observed this promenade in any other species. Sometimes a coupled pair on a leaf of a tree (high up from the ground), remain for several minutes. I have watched swallows and martins unsuccessfully attempting to capture some of the high-flying *Tramea lacerata* and *onusta* and *Epicordula princeps*. The dragon flies await the rush of the swallow until the bird approaches within a few feet, then arise with extreme rapidity a distance of about two feet and allow the bird to pass beneath them. The dragon flies really seemed to enjoy the exercise. On the other hand, I have seen *Libellula* caught with ease by flickers. Common from July on.

Out of a dozen or more species I have only one whose rear wing is not badly damaged (I am speaking of the female only). I am at a loss to explain this except on the grounds of the honeymoon parade.

ZYGOPTERA. Wings folded when at rest (*Lestes*, half folded).

1. *Anomalagrion hastatum* Say (*anomales*, Gr., irregular; *agrion*, Gr., wild animal; *hastatum*, Lat., armed with a spear). Abdomen: male, 18 mm., female, 19 mm. Hind wing: male, 11 mm.; female, 13 mm.

Male: Orange or yellow. Vertex black. Spots behind the eyes are small and not connected. Wide mid-stripe on the top of the thorax; shoulder stripes and spot above on the second suture, bronze-black. Abdomen yellow or orange with bronze-black, as follows: all of segments 1 and 2, much of 3 (basal and outer spots on 3, usually meeting on the mid-line), basal and outer spots (variable in size) on 4 and 6, and on 7 basally. Apical spot on front wing removed from the first row, oval, reddish; on the hind wing normal in position, black. The back end of the top side of segment 10 bears a slender two-pronged spine. Superior abdominal appendages are half as long as segment 10, two-pronged; inferiors a little longer than the superiors. Legs pale, lined with dark.

Black female: Similar to male. Top of abdomen black; pale, interrupted basal rings on segments 3 to 6. Apical spot displaced; brown alike on all wings.

Orange female: Similar to male; spots back of the eyes are continuous with the orange on the back of the head. Shoulder stripe on thorax reduced or wanting. Abdomen with a spot on the middle of the top of segment 1, at base of 2; outer rings on 2 to 4, and all of 5 or 6 to 8 or 9, bronze-black.

Habits: Not common. June on. Marshes and swamps bordering streams or still water.

2. *Argia apicalis* Say (*apex*, Lat, extreme end). Abdomen: male, 29 mm.; female, 31 mm. Hind wing: male, 21 mm.; female, 23 mm.

Male: Pale blue or drab. Vertex, mid-stripe on top of thorax, and a spot on the shoulder suture above and below, black. Abdomen dark brown or black, segments 3 to 7 with pale, narrow basal rings; last two segments blue.

Female: Young are light brown; adult blue, like male. Shoulder stripes small or wanting. Abdomen dark; top black with the outer half of segment 9

and all of 10, yellow. Adults are distinguished from *putrida* by the brighter and clearer color of the thorax.

Habits Like *putrida*. June on.

3. *Argia putrida* Rambur (*argia*, Gr, idleness; *putridus*, Lat, polluted). Abdomen male, 34 mm.; female, 32 mm Hind wing: male, 24 mm.; female, 25 mm.

Male Gray or light brown Vertex, mid-stripe on top of thorax and a stripe on either side, black. Abdomen black; first segment sometimes pale above; 3 to 7 with pale, narrow basal rings Older males chalky Wings with the upper sector of the triangle ending on the margin far out and almost on a level with the apical spot. Legs pale, lined with dark. Apex of segment 10 cut out, sides produced Appendages short

Female Younger specimens brown, much like male, with abdomen mostly brown. Mature females have the head and thorax pale blue, with black mid-markings on the top of the thorax and very narrow black lines on the sutures. Abdomen brown above, bounded on either side with an interrupted black stripe, below the black, pale blue or greenish.

Habits Common from July on, about both still and running water In contradistinction to the *Lestes*, *Enallagmas* and other smaller Agrionines, it prefers the glaring sun of the rocky or bare banks to the rank grasses and weeds

4 *Argia violacea* Hagen (*violaceus*, Lat, violet colored) Abdomen male, 26 mm, female, 25 mm. Hind wing male, 20 mm, female, 21 mm.

Male Violet Thorax with black mid-stripe on top, shoulder stripe, and narrow lines on the side sutures Abdomen violet, with the following black interrupted ring on outer end of segments 2, 3 and 4, outer rings on 5 and 6, all of 7 excepting a basal ring; last two segments blue. Legs pale with dark lines.

Female Brown or dull violet. Abdomen brown above, bounded on either side with an interrupted black stripe, pale blue or greenish below the black.

Habits similar to *A. apicalis*; spends more time on the wing. June on.

5 *Enallagma aspersum* Hagen (*aspersus*, Lat, spotted) Abdomen male, 25 mm.; female, 24 mm. Hind wing both 18 mm.

Male Blue Vertex black Connected blue spots behind the eyes. Thorax with mid-stripe on top and shoulder stripes black. Abdomen blue; black as follows. basal spot on segment 1, outer spot on 2, outer two-thirds of 3, all of 4 to 6 (except narrow interrupted basal rings), basal half of 7 and 10

Female. Lighter than male. Top of segments 1 to 10 with a longitudinal band, reduced to a narrow stripe on the greater part of 7 and 8, and interrupted basal rings on 3 to 6, black

Habits similar to the preceding species June on

6. *Enallagma civile* Hagen (*civilis*, Lat, of citizens or civil). Abdomen: male, 25 mm., female, 27 mm Hind wing male, 18 mm., female, 20 mm.

Male Blue Large connected blue spots behind the eyes. Thorax with mid-stripe on top and shoulder stripes, black The abdomen is blue; black as follows. basal spot on segment 1, outer spot on 2, outer third or fourth of 3 to 5, outer two-thirds of 6, all of 7 except an interrupted basal ring, and the top of 10.

Female: Blue of the male is replaced by a lighter blue, or yellowish green.

Habits: The habits of the *Enallagma* will be given under *Enallagma signatum*. June on.

7. *Enallagma signatum* Hagen (*enallatte*, Gr., to exchange or differ from; *signatus*, Lat., marked). Abdomen: male, 28 mm.; female, 27 mm. Hind wing: male, 17 mm.; female, 18 mm.

Male: Orange. Connected orange spots on the back of the head. Thorax with several bronze-black or dark green stripes; the shoulder stripe sometimes has a lilac or greenish stripe lying just below it. The top of the abdomen is black; all of segment 9 and the sides of 10, orange or pale yellow. Legs pale yellow.

Female: Similar. Usually more bluish than yellow. The sides of segment 9 are yellow, barely coming together at the outer end of the segment; 10 is entirely yellow. Legs darker than the male.

Habits: Common; graceful, active. Frequents sluggish or still water. Females rest in the weeds on the bank when not pairing or ovipositing. Males sun themselves on the lily pads some distance out from the bank. The tenerals are dull blue. June on.

8. *Ischnura verticalis* Say (*ischnos*, Gr., lean; *ouri*, Gr., tail; *vertex*, Lat., highest point) Abdomen male, 20 mm ; black female, 21 mm.; orange female, 22 mm Hind wing male, 13 mm , black female, 14 mm.; orange female, 15 mm

Male Green. A short blue line connecting the eyes Thorax striped with black The top of the abdomen is black; segments 8 and 9 bright blue with a black stripe on either side Apical spot on the front wings is black, on the hind wings brown

Black female Similar to male except that segments 8, 9 and 10 are black The older specimens may be chalky white The black female is more common than the orange female in autumn

Orange female Orange and bronze-black The top of segments 4 to 10 are bronze-black The sides of the abdomen and thorax are greenish, likely to be chalky white. In the spring the chalky-white females are more numerous than either the bright orange or black females

Habits Very weak fliers, blown about by the wind They choose sheltered resting places Common from June on

9 *Lestes unguiculatus* Hagen (*lestes*, Gr , a plunderer; *unguiculus*, Lat , a finger nail). Abdomen male, 28 mm , female, 27 mm. Hind wing male, 19 mm., female, 21 mm

Male Blackish brown A collar, shoulder sutures, face, under parts of the head, under parts of the thorax, yellow Top of the abdomen is metallic green or brown, narrow interrupted basal rings on segments W to 7, passing into yellow on the sides of 1 to 7. The mature specimens of both sexes are more or less chalky white The apical spot is brown, whitish at either end Legs black and pale

Female Similar Shoulder stripes wider The rear of the head has a yellow band from eye to eye, obscure in older individuals

Habits Found about water, resting on dry weeds on the bank, not on the aquatic plants Not common July on

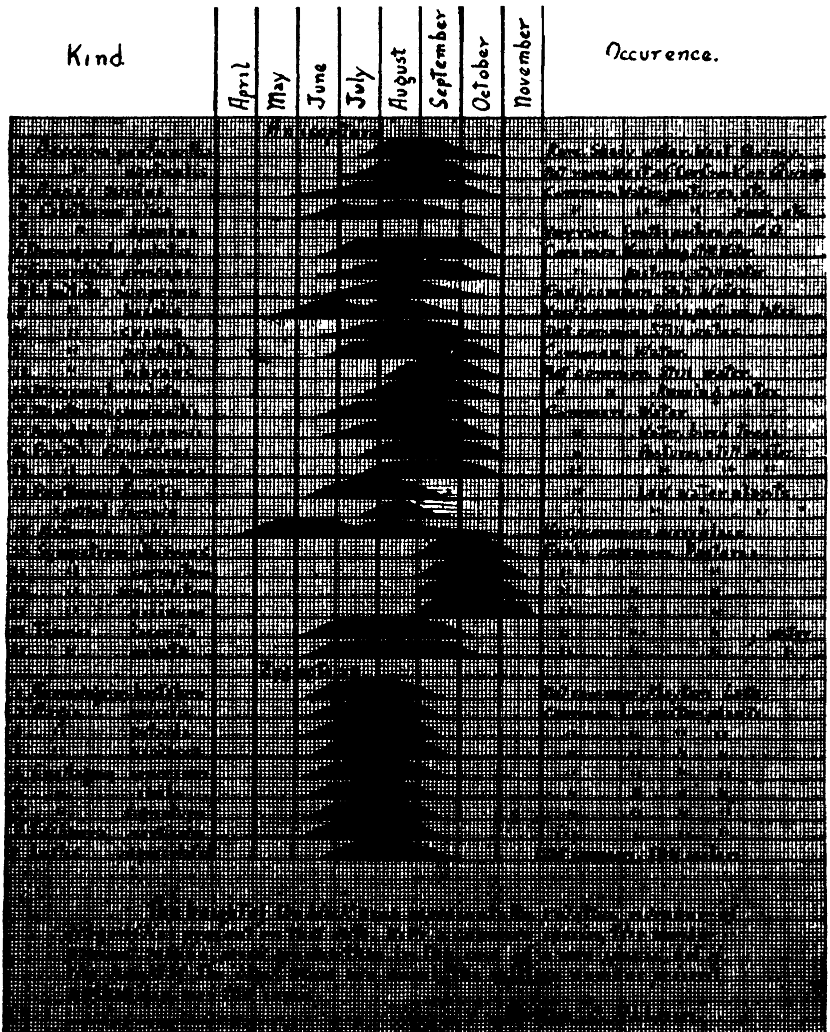
ORDER ODONATA.

SUBORDER ANISOPTERA

	Family	Subfamily	Genus	Species
1.	Æschnidæ	Æschninæ	Æschna	pentacantha
2	Æschnidæ	Æschninæ	Æschna	verticalis
3	Æschnidæ	Æschninæ	Anax	junius.
4.	Libellulidæ	Libellulinæ	Celethemis	elisa.
5	Libellulidæ	Libellulinæ	Celethemis	eponina
6.	Æschnidæ	Gomphinæ	Dromogomphus	spoliatus.
7.	Libellulidæ	Cordulinæ	Epicordula	princeps.
8.	Libellulidæ	Libellulinæ	Libellula	auripennis.
9.	Libellulidæ	Libellulinæ	Libellula	basalis.
10.	Libellulidæ	Libellulinæ	Libellula	cyanea.
11	Libellulidæ	Libellulinæ	Libellula	pulchella.
12	Libellulidæ	Libellulinæ	Libellula	vibrans.
13.	Libellulidæ	Cordulinæ	Macromia	tæniolata.
14.	Libellulidæ	Libellulinæ	Mesothemis	simplicollis.
15.	Libellulidæ	Libellulinæ	Pachydiplax	longipennis.
16.	Libellulidæ	Libellulinæ	Pantala	hymenæa.
17.	Libellulidæ	Libellulinæ	Pantala	flavescens.
18.	Libellulidæ	Libellulinæ	Perithemis	domitia.
19.	Libellulidæ	Libellulinæ	Plathemis	lydia.
20.	Libellulidæ	Libellulinæ	Sympetrum	albifrons.
21.	Libellulidæ	Libellulinæ	Sympetrum	corruptum.
22.	Libellulidæ	Libellulinæ	Sympetrum	semicinctum.
23.	Libellulidæ	Libellulinæ	Sympetrum	vicinum.
24.	Libellulidæ	Libellulinæ	Tramea	lacerata.
25.	Libellulidæ	Libellulinæ	Tramea	onusta.

SUBORDER ZYGOPTERA.

1.	Agrionidæ	Agrionæ	Anomalagrion	hastatum.
2.	Agrionidæ	Agrionæ	Argia	apicalis.
3.	Agrionidæ	Agrionæ	Argia	putrida.
4.	Agrionidæ	Agrionæ	Argia	violacea.
5.	Agrionidæ	Agrionæ	Enallagma	aspersum.
6.	Agrionidæ	Agrionæ	Enallagma	civile.
7.	Agrionidæ	Agrionæ	Enallagma	signatum.
8.	Agrionidæ	Agrionæ	Ischnura	verticalis.
9.	Agrionidæ	Agrionæ	Lestes	unguiculatus.



NOTE.—The imagoes emerge from the nymph stage between daybreak and sunrise.
NOTE.—The dimensions given in the keys may vary 15 or 20 per cent.

A List of the Butterflies of Crawford County, Kansas.

VANCE RANDOLPH.

I am convinced, after six consecutive seasons of collecting, that not more than fifty-two species of butterflies occur within the confines of Crawford county. Forty-nine of these are listed in the following pages. The three whose names are lacking were hesperids, collected near Pittsburg in 1914, which I was unable to classify further at that time. The specimens were lost in the fire which destroyed Russ hall in 1915, and I have since been unable to replace them.

Believing that an authentic record of this sort may be of value to some local lepidopterist of the future, I have prepared this list and am placing it in the hands of Dr. O. P Dellinger, under whose personal direction my work was done, asking that it may be preserved in the library of the department.

One of the most discouraging obstacles in the way of the popularization of nature study is the formidable terminology employed. With this difficulty in mind, I have indicated the pronunciation of the Latin terms, and have added also a list of so-called popular names, taking most of them from Holland, some from Maynard, and a few from Comstock.

ORDER LEPIDOPTERA (Lep-i-dop'te-ra).

SUBORDER RHOPALOCERA (Rho-pal-o-ce-ra).

I. FAMILY NYMPHALIDÆ (Nym-pha'li-dæ).

1. Subfamily EUPLŒINÆ (Eu-plœ-i'næ).
   Anosia plexippus. The Monarch.
   (A-no'si-a plex-ip'pus)

2. Subfamily NYMPHALINÆ (Nym-pha-li'næ).
   Dione vanillæ. The Red Silverspot.
   (Di-on'e va-nil'læ)

   Euptoieta claudia. The Dull Meadow.
   (Eup-toi-e'ta clau'di-a.)

   Argynnis idalia. The Royal Silverspot.
   (Ar-gyn'nis i-da'li-a)

   Argynnis cybele. The Brown Silverspot.
   (Ar-gyn'nis cyb'e-le)

   Melitæ phaeton. The Baltimore.
   (Me-li'tæ pha'e-ton.)

   Phyciodes tharos. The Pearl Crescent.
   (Phy-ci-o'des tha'ros.)

   Grapta comma. The Comma.
   (Grap'ta com'ma)

   Grapta interrogationis. The Question Mark.
   (Grap'ta in-ter-ro-ga-ti-o'nis)

Vanessa antiopa. The Mourning Cloak
(Va-nes'sa an-ti'o-pa.)

Pyrameis atalanta. The Red Admiral.
(Py-ra-me'is at-a-lan'ta.)

Pyrameis cardui. The Painted Lady
(Py-ra-me'is car'du-i.)

Pyrameis huntera. Hunter's Butterfly
(Py-ra-me'is hun'te-ra.)

Junonia cœnia. The Peacock.
(Ju-no-ni-a cœ-ni-a.)

Basilarchia astyanax. The Red-spotted Purple.
(Bas-i-lar'chi-a as-ty'a-nax.)

Basilarchia disippus. The Viceroy.
(Bas-i-lar'chi-a di-sip'pus.)

Chlorippe celtis. The Hackberry Butterfly.
(Chlo-rip-pe cel'tis.)

Chlorippe clyton. The Tawny Emperor
(Chlo-rip-pe cly-ton.)

Pyrrhanœa andria. The Red Brick
(Pyr-rha-næ-a an'dri-a.)

3. Subfamily SATYRINÆ (Sat-y-ri'næ)

Neonympha eurytus. The Wood Satyr
(Ne-o-nym-pha eu'ry-tus.)

Satyrus alope. The Wood Nymph
(Sat-y-rus al'op-e.)

Satyrus nephele. The Clouded Nymph
(Sat-y-rus neph'e-le.)

4. Subfamily LIBYTHEINÆ (Li-byth-e-i'næ)

Libythea bachmanni. The Snout Butterfly
(Li-byth'e-a bach-man'ni.)

II. FAMILY LYCÆNIDÆ (Ly-cæ-ni'dæ).

1. Subfamily LYCÆNINÆ (Ly-cæ-ni'næ).

Thecla melinus. The Common Hairstreak.
(Thec'la mel'i-nus.)

Thecla cerops. Hubner's Hairstreak.
(Thec'la cer'ops.)

Lycæna pseudargiolus. The Common Blue
(Ly-cæn'a pseud-ar-gi'o-lus.)

Feniseca tarquinius. The Harvester
(Fe-nis'e-ca tar-quin'i-us.)

III. FAMILY PAPILIONIDÆ (Pa-pil-i-on'i-dæ).

1. Subfamily PIERINÆ (Pi-er-in'æ).

Pieris protodice. The Common White.
(Pi'e-ris pro-tod'i-ce.)

Pieris rapæ. The Cabbage Butterfly.
(Pi'e-ris ra'pæ.)

Nathalis iole. The Dwarf Sulphur.
(Na-tha'lis i'o-le)

Catopsilia eubule. The Cloudless Yellow.
(Ca-top-si-li-a eu-bu'le)

Meganostoma cæsonia. Southern Dog-face.
(Me-gan-o-sto-ma cæ-so'ni-a)

Colias eurytheme The Common Yellow.
(Co'li-as eu-ryth'e-me)

Colias philodice. The Common Sulphur.
(Co'li-as phi-lod'i-ce)

Terias lisa. The Little Yellow.
(Te-ri'as li'sa)

Terias mexicana. The Mexican Yellow
(Te-ri'as mex-i-can'a)

Terias nicippe The Black-bordered Yellow
(Te-ri'as ni-cip'pe)

2. Subfamily PAPILIONINÆ (Pa-pil-i-o-ni'næ)

Papilio ajax. The Green Swallowtail.
(Pa-pil'i-o a'jax)

Papilio troilus The Spice-bush Swallowtail
(Pa-pil'i-o troi-lus)

Papilio turnus The Yellow Swallowtail.
(Pa-pil'i-o tur'nus)

Papilio cresphontes The Giant Swallowtail.
(Pa-pil'i-o cres-phon'tes)

Papilio asterias The Eastern Swallowtail
(Pa-pil'i-o as-ter'i-as)

Papilio philenor. The Shining Swallowtail.
(Pa-pil'i-o phil'e-nor)

IV. FAMILY HESPERIIDÆ (Hes-pe-ri'i-dæ)

1. Subfamily HESPERIINÆ (Hes-pe-ri-i'næ).

Epargyreus tityrus. Silver-spotted Skipper.
(Ep-ar-gy're-us tit'y-rus)

Hesperia montivago. Checkered Skipper.
(Hes-pe'ri-a mon-ti-va'go)

Thorybes bathillus. Southern Dusky-wing.
(Thor'y-bes ba-thyl'lus)

Thanaos martialis. Martial's Dusky-wing.
(Than'a-os mar-ti-a'lis)

2. Subfamily PAMPHILINÆ (Pam-phi-li'næ).

Ancyloxypha numitor. The Numitor.
(An-cy-lox'i-pha nu'mi-tor)

Atalopedes huron. The Sachem.
(A-tal-o'pe-des hu'ron)

The Weakening Effect on a Species of Plants of Being Continually Reproduced by Artificial Means.

E F. A. REINISCH.

The natural reproduction of plants is by their seeds, like all of our cereals, grasses, annual flowering plants, etc.

The artificial methods are root divisions, layering, grafting, and cuttings. However careful the artificial operations are performed, there is always a surface unprotected by bark or callus, which is exposed to the soil and its moisture contents till the plant is able to gradually heal the wound by its own life force. Until this is done there are many chances for disease to attack the small exposed surface and retard the process of healing, sometimes preventing it entirely, in which case the bark decays back at some little distance to where roots existed or have been newly formed.

In division, the section taken away to form a new plant receives a portion of the root stock of the mother plant, and with it life and energy to start out as a new individual

In layering, the new plant to-be is a branch or stem, a portion of which is layered in the soil with the top projecting out of it. This is left in the ground during the growing season, when roots are formed, induced by the moisture of the ground. The following dormant season the branch or stem is cut off at the ground next to the mother plant, dug up, and planted as a new individual.

In grafting, the species or variety to be propagated is worked on another plant of the same or a related genus or species by inserting a bud under the bark, or by other modes of grafting when twigs or scions are used instead of buds.

In the preceding two artificial methods of reproduction the new plant has been attached to some growing plant, from which it received life and nourishment until it became a self-sustaining individual. In this last method—propagation by cuttings—a piece of the plant to be propagated is cut off and inserted into the soil, to become a new plant, sustained only by its own life and moisture of the soil and atmosphere till it creates its own root system and becomes an independent plant.

A great many species and varieties must be reproduced by artificial means, as they do not come true from seed, like our own apples and other fruits and many ornamental and greenhouse plants. Others, again, never produce seeds, like the bud varieties, such as the globe and weeping trees and many variegated plants. These bud varieties or sports are chance products of nature, and are in many cases constant; that is, they retain their characteristics unchanged, even when transferred to other soils and climates. One of these varieties is the Lombardy poplar of which I will speak in detail and make my point in regard to the weakening effect mentioned in the title of this paper.

THE LOMBARDY POPLAR *(Populus nigra Italica)*. In Lombardy (a province of Italy) a black poplar *(P. nigra)* was found with a branch entirely different from the balance of the tree, which, though somewhat pyramidal in outline, is much more spreading than this particular branch, the twigs of which showed a tendency of growing close together, forming an almost cylindrical mass. The poplars are diœcious trees, having stamens on one plant and pistils on

another. It was a sport on a staminate specimen, and on account of its striking habit was at once propagated, and has since spread over all countries of the globe. This was in the first decade of the eighteenth century, and the tree has, under all conditions of soil and climate, retained its peculiar characteristics unchanged through more than two centuries.

The story of its appearance in continental Europe is as follows. "A merchant in northern Europe received a shipment of fruit from Italy, packed in willow-twig baskets. The merchant noticed that some of the twigs had a very light gray bark. A willow of this color he had never seen before. On close examination he found that the bark was yet green and the buds very little shriveled, so he carefully unwound the baskets and made cuttings of the newly discovered willow. Some of them grew, and proved to be a new and interesting poplar."

From this small start the tree spread rapidly and soon appeared all over Europe, and finally, in less than one hundred years after its first discovery in Italy, was introduced in America.

The striking contrast with other trees and its usefulness in the variation of the sky line made it a desirable material for group and specimen plantings in parks and gardens, and soon was extensively propagated by nurserymen.

In 1872 I saw beautiful, large and healthy specimens in Pennsylvania and New Jersey. Some of them were at least forty years old, perfectly sound and uninjured by wind and cold. But trees I planted in the Topeka parks since 1900 showed unmistakable signs of decay when not more than ten years old, and in a few years more commenced to die and break off.

In examining the young trees when a year old I find that about 10 per cent have not covered the base cut with callus. The cutting turned black about an inch up and a few roots formed from the glands in the bark. By dissecting the plants I found that the decay had followed up the pith the full length of the cutting. The branches and roots were thin and the leaves smaller than those of the healthy plants. Where great care is not exercised in selecting the cuttings it will be seen that this weakness or disease will be inherited by all the descendants of the weak ancestor.

The only way to produce a healthier race of this valuable tree is by careful selection, using the healthiest wood of the healthiest trees, making both the upper and lower cut smooth, by using a sharp knife. Dip the upper cut in oil paint to exclude air and moisture, and protect the lower cut by rubbing powdered charcoal well over the surface, and if possible plant them in a sandy soil.

Problems in Artillery Ammunition Design.

R. A. SEATON.

Because of the very wide field covered by the subject as assigned to me (Scientific Engineering Problems in Ordnance Manufacture), I am limiting myself to one phase only of the subject, as indicated in the title of the paper; and the treatment of this phase is necessarily incomplete because of the limited time at my disposal and because of the complex nature of the subject. The mathematical details are eliminated in so far as possible, and an effort is made to give a more or less popular presentation of the subject in order that you may not be wearied by the more technical details.

EARLY FORMS OF AMMUNITION.

The early forms of projectiles used in cannon were solid, spherical cast-iron shot, grape and canister, the two latter being composed of a number of round shot of much smaller diameter than the bore of the gun, temporarily held together by a can, or by rods and plates, to facilitate loading. The fastenings were made so light that they would not withstand the shock of discharge from the cannon, so that the effect was very much the same as though the balls had been loaded loosely into the gun, the cannon becoming essentially a huge shotgun.

Grape and canister were ineffective except at very short ranges, and the damage done by the solid spherical shot was very small, even when a direct hit was made. An improvement was made when an explosive elongated shell loaded with black powder was introduced, but this was still very ineffective as compared with the modern high-explosive projectile

MODERN FORMS OF AMMUNITION.

With the discovery of so-called high explosives it became possible to very greatly increase the effectiveness of projectiles against both personnel and fortifications. The modern high-explosive shell consists of a hollow steel cylinder with a conical or ogival point, filled with a high explosive sufficiently insensitive to resist the shock of discharge and capable of being detonated by a fuse fitted to the projectile. When used against matériel the shell itself acts chiefly as a carrier for the high explosive, the damage being done by the violent detonation of the explosive. When used against personnel, however, the fragments into which the shell is blown by the high explosive are projected with a high velocity and serve to materially increase the effectiveness. Early in the war it was found by experience that the effectiveness of the shell against matériel was in direct proportion to the amount of high explosive contained, so that the modern shell is made with walls as thin as will safely stand the shock of discharge, in order to carry as large an amount of explosive as possible without exceeding the permissible weight

In chemical shells—a new development of this war—the effect is, of course, proportional to the amount of chemical which the shell carries, so that in this, also, it is necessary that the shell itself be made with as thin walls as possible.

Shrapnel, which before the war was considered to be one of the most effective forms of ammunition, proved to be relatively unimportant except against massed troops in the open—a target not often found. The shrapnel consists of a hollow steel cylinder with a pointed end, which contains a very large number of lead bullets. A pocket between the bullets and the base of the shell contains black powder, which is ignited by a time fuse while the shrapnel is still some distance from the target. This black powder blows the bullets forward and downward, spraying them over a wide area, each bullet being intended to have sufficient velocity to kill a man or horse on striking one. The shrapnel case is not blown to pieces, so that it is entirely ineffective unless it should happen to strike a living target. It can, therefore, be seen that it is desirable to make the shrapnel cases with as thin walls as possible in order that the major portion of the weight of the projectile may consist of bullets.

STRESSES IN FIRING.

The design of these shell bodies and shrapnel cases involves some rather interesting problems in the strength of materials.

With the improvement in the materials used in the manufacture of cannon, the powder pressures used have increased until at the present time pressures of 38,000 to 40,000 pounds per square inch are common. When this pressure is compared with that of about 100 to 150 pounds per square inch used in high-pressure steam boilers, or about 200 to 500 pounds per square inch in gas engines, it can be realized what enormous forces are brought to bear on the projectiles when these are being fired from the cannon. The powder pressure acts on the base of the projectile, which in turn pushes forward on the side walls The inertia of the walls and the forward part of the shell tends to resist this pressure, so that a very heavy compressive stress is set up in the walls This is the most obvious stress on the projectile walls, and the one which until quite recently was used as a basis for the design of projectiles The intensity of the stress can easily be computed by the simple formula of mechanics—force equals mass times acceleration

This is not the only important stress, however, and when it was used alone for the design of projectiles it was necessary to use a factor of safety, or, more accurately, a factor of ignorance, which sometimes gave satisfactory results and sometimes did not The introduction of semisteel shells brought out clearly the defects of this method of design, for these shells failed at compressive stresses far below what the material could safely stand, and forced the conclusion that failure was not due primarily to these compressive stresses, but to hoop tension developed in the walls due to the pressure of the contained charge. These stresses are brought to bear in the following manner.

The high explosives which are commonly used are solids, and may be in the form of a powder pressed into the shell or may be melted and poured into it When the shell is fired from the cannon the inertia of the charge tends to cause it to lag behind, while the particles to the rear force it ahead. This sets up a heavy internal pressure in the charge, which is greatest near the base of the shell. In shells used in the United States army this intensity of pressure frequently runs up to more than 10,000 pounds per square inch. Under such enormous pressures it is probable that the charge acts as though it were a fluid, in much the same way that the ice of glaciers acts like a fluid under heavy pressures Consequently, the shell is in the condition of a hollow cylinder subjected to a very high internal fluid pressure, which tends to burst the walls by hoop tension. In the chemical shells the shell filler is a liquid, and it is obvious that these shells are also subjected to this hoop tension.

This tensile stress in the walls of the shells frequently runs as high as, or higher than, the compressive stresses in the walls due to direct powder pressure. As the tensile strength of semisteel is only from one-third or one-fourth of the compressive strength, it can readily be seen why the attempt to design semisteel shells on the basis of compressive stresses gave unsatisfactory results. The effect of the longitudinal compression and the hoop tension acting simultaneously is much more severe than it would be for either of these acting singly, and it is commonly the combined effect of these stresses which limits the ability of either steel or semisteel shells to with-

stand discharge from the gun. A number of other stresses also exist, such as those due to centrifugal force and to the rapid angular acceleration of the shell, but these may usually be neglected without serious error.

HIGH QUALITY OF STEEL REQUIRED.

The combined stresses in shells used in our service frequently run as high as 60,000 pounds per square inch, which makes necessary the use of a high quality of steel in their manufacture. Ordinary steels are not able to withstand these stresses, and if used without special treatment would allow the shell to swell in the bore of the gun. This would be very likely to cause a premature detonation of the charge, with the destruction of the gun and its crew. On the other hand, high carbon steels of the quality which could safely withstand these stresses would be so hard as to make it difficult and expensive to manufacture them. It is therefore necessary to make use of an intermediate quality of steel and by the use of appropriate heat treatment after the shell is manufactured to give it the desired strength. When semi-steel is used for shell manufacture a radically different design must be used, with much lower tensile stresses. This considerably reduces the amount of charge which can be carried and renders the shell inefficient.

The very high stresses developed, and the seriousness of a possible failure of the shell to stand up properly under firing, make necessary very careful inspection and testing of the shells during and after manufacture. The final test as to the acceptability of the shell is, of course, the firing test, and this is made upon a considerable percentage of all shells manufactured, a non-explosive charge of the same specific gravity as the high explosive being used. In order to give a margin for safety, a powder pressure about 12 per cent in excess of the normal is used. The shells are recovered after firing, and inspected to observe whether any appreciable swelling has taken place. If this has occurred the entire lot from which the samples were taken must be rejected.

INCREASED RANGES USED.

One of the important developments of this war has been the increase of range obtained with the artillery. The importance of being able to outrange the enemy is obvious. It was largely because the French 75 mm. guns outranged the German guns of a similar caliber that the French were able to stop the Germans in the early part of the war in spite of great disadvantages in other respects. The Germans recognized this, and greatly improved the ranges of their various calibers of guns during the progress of the war.

An increase in range can be secured in one of three different ways, or by a combination of these, namely, (*a*) by increasing the powder pressure; (*b*) by increasing the length of the gun, so that the powder pressure can act on the projectile for a longer time; or (*c*) by improving the shape of the projectile.

Either of the first two methods will result in giving the projectile an increased muzzle velocity, while the third method will result in decreasing the resistance of the air to the flight of the projectile.

Disadvantages attending the increase of powder pressures are that the stresses in both gun and projectile are increased, erosion of the gun is increased, and its life is shortened. The gun must be made heavier to stand the increased stresses, and it consequently becomes less mobile.

Increasing the length of the gun also increases the weight and makes the gun less mobile. It is therefore highly desirable that the improvement in the shape of the projectile should be carried as far as practicable.

EFFECT OF SHAPE OF PROJECTILE ON RANGE.

In a vacuum the path or trajectory of a projectile would be a parabola, and the projectile would have the same velocity at the target that it had at the muzzle of the gun, assuming these to be in the same horizontal plane. The maximum range would be obtained with an angle of elevation of 45 degrees and the range obtained for any given angle of elevation would be directly proportional to the square of the muzzle velocity. It may be noted in passing that in a vacuum the axis of the projectile would not remain tangent to the projectile's path, but would remain always parallel to its original direction.

At the high velocities used with guns the resistance of the air to the motion of the projectile becomes very important. With certain artillery projectiles used in our service the air resistance at service velocities is a force equal to from ten to fifteen times the weight of the projectile. Due to this resistance, the range is greatly decreased, the path is no longer a parabola, and the range is no longer proportional to the square of the muzzle velocity.

It is readily seen that the ability of the projectile to penetrate a resisting medium such as the air will depend on the pointedness of the projectile, and that the more pointed the projectile the greater the range that can be obtained with a given muzzle velocity. It can also be seen that for a given resistance of the air the retardation will be inversely proportional to the weight of the projectile. It follows, therefore, that increasing the length of the projectile of a given size will increase the range, since this will increase the weight without greatly affecting the air resistance. This is one of the great advantages of the cylindrical-ogival form of shell over the spherical one. But there is a limit beyond which the increase of length must not be carried. When the latter becomes greater than about four times the diameter, the projectile becomes unstable and will no longer move point forward, but will tumble and thus present a very greatly increased area to the resisting air, and the range will be short and very erratic. The length of projectile which will be stable may be increased somewhat by the use of a light, hollow cap, which will throw the center of pressure forward without greatly disturbing the position of the center of gravity.

Another method used to decrease the resistance of the air is to slightly taper the rear end of the projectile, very much in the same way that the rear portion of the boat is tapered. It is because of this similarity that this tapering is given the name of boat-tailing. Boat-tailing has been very generally used on projectiles designed in the last few years.

OTHER FACTORS AFFECTING RANGE.

Another very important factor which affects the range of projectiles is the air density. The retardation is directly proportional to the density of the air, and consequently an increase or decrease of one inch in the barometer will change the retardation by about one-thirtieth of its value. It is an interesting fact not usually understood that a moderate change in the barometer will change the range of a projectile more than a strong head wind.

The modern long ranges are obtained by firing at high angles of elevation,

the maximum range being obtained at an angle of from 40 to 50 degrees. The projectile, therefore, rises to a considerable height above the earth, and the air density at this altitude is much less than that at the surface of the earth, thus materially decreasing the retardation of the projectile

POSSIBILITIES OF VERY LONG RANGES.

The firing of shells upon Paris by the Germans from a distance of about 75 miles has drawn attention to the possibility of securing very long ranges

It happened that I was in the ordnance department at Washington at the time the Germans began firing these projectiles, and the War Department called upon me to calculate the elements of the trajectory and determine whether it were possible that the Germans were really firing on Paris from such a distance as was reported.

Ballistic calculations are usually made by the aid of tables, in very much the same way that tables of the functions of the angles are used in the solution of problems in trigonometry A brief preliminary investigation showed that while the tables extended only to a velocity of 3,600 feet per second, this velocity would be much too low to give the necessary range It was therefore necessary to resort to an analytical solution based on graphical analysis, and to solve the trajectory step by step The process was a tedious one, but the calculations gave the desired results. It was found that for the assumed data regarding the projectile, and an angle of elevation of 50 degrees, a muzzle velocity of about 5,000 feet per second was required, that the projectile would rise to a height of about 25 miles above the surface of the earth, that the time of flight would be about 3 minutes, the angle of fall about 56 degrees, and the striking velocity about 2,800 feet per second These results check satisfactorily with the latest information available

It should be noted that in making these calculations it was necessary to extend both the laws of variation of air resistance with velocity, and of air density with altitude, far beyond the limits of experimental data. Very little experimental work has been done with velocities greater than 3,000 feet per second, while 25 miles above the earth's surface is several times as high as has ever been reached by man

It is interesting to compare these results with the values required to give a 75-mile range *in vacuo* with an angle of elevation of 50 degrees. Very simple calculations show, for the latter case, that the muzzle velocity required is about 3,600 feet per second, the maximum height above the earth's surface about 22 miles, and the time of flight about 171 seconds. The only one of these values differing greatly from the corresponding one for flight in air is the muzzle velocity. The reason for this is that the major portion of the actual trajectory was in what is practically a vacuum. About four-fifths of the range was covered at a height of over nine miles above the earth's surface, and hence in an air density less than one-seventh that at the earth's surface, while the density at the highest point of the trajectory is about 1/200 that at the earth's surface. The great decrease in velocity of the projectile comes in the first few miles of its travel, while it is going through the dense atmosphere near the earth.

There is no question but that had the war continued there would have been further development in the matter of very long ranges. How far the increase in range would have gone is problematical.

It may be interesting to note in this connection that calculations show that, neglecting the retardation of the air, it would require a muzzle velocity of only about seven miles per second to make a projectile leave the earth entirely and never return, while with a velocity of about five miles per second, only five times that reached in the German gun, the projectile would revolve around the earth as a satellite Obviously, velocities somewhat short of these values would be sufficient to reach from any one point of the earth's surface to any other point, if the resistance of the air could be neglected. To actually accomplish the result it would be necessary only to give a sufficient added velocity to the projectile so that it might have the velocity mentioned by the time it had risen above the earth's atmosphere. Whether it will ever be possible to design a gun capable of giving such a velocity to a projectile is a problem for the future

Factors Influencing the Teaching of Science and Engineering.

A A POTTER

The following factors contribute to efficient instruction

1 ORGANIZATION The duties of every person connected with the administration, instruction and research activities of an educational institution should be carefully worked out, showing lines of authority and of responsibility. A diagram should then be drawn up which shows at a glance to whom each individual in the organization is responsible, and the main duties, whether executive, teaching or investigational, every person is performing This chart should be supplemented by departmental charts and by written instructions, which should set forth details of organization

It should be the duty of the head of the institution to familiarize the heads of the various departments with the organization. The heads of departments should be held responsible for the quality of instruction in their departments

To correlate the work of the various instructors in any given department, frequent conferences should be held of all instructors teaching the same or related subjects These conferences should be very informal and should aid in developing *esprit de corps* among the instructors, while improving teaching methods and bringing out defects in textbooks, schedules of assignments, subject matter, etc

The head of the institution should also hold frequent conferences of all department heads in order to correlate the work of the various departments and to discuss administrative details Matters affecting the entire teaching force should be discussed at general meetings, which should be attended by every person connected with the institution

When several instructors are teaching the same subject, but to different sections, the schedule of instruction should be planned by a committee including all such instructors, and in coöperation with the head of the department. If at all possible, where several instructors are handling the same subject, the sections should be arranged so that men possessing similar qualifications are assigned to the same section. Greatest aid—that is, better teachers and smaller sections—should be set aside for those students of lesser ability who show a desire to make most of their opportunity.

Every effort should be exerted to build upon a man's ability, knowledge and experience. This means that every student is carefully tested before being assigned to any particular class, and his progress is carefully watched.

2. INSTRUCTORS. The personality, ability, education and experience of the instructors have more to do with the success of any educational institution than all other factors combined. A good instructor has a thorough knowledge of his subject, is familiar with the best teaching methods, understands human nature, and is able to interest and to enthuse his students in the subject he is teaching, while stimulating each man's imagination and developing the student's initiative.

The personal relations which exist between the instructor and his students influence the results attained. An instructor who exhibits too much superiority will prevent students from seeking guidance at a time when such assistance will do most good. An easy-going instructor will retard the development of the students' initiative and imagination.

An instructor of engineering subjects should have practical knowledge, in order that he may be in a position to distinguish the essential from the non-essential. On the other hand, a man with too much practical experience often makes a poor instructor, as he expects too much of his students, takes too much for granted, or spends too much time in imparting specialized knowledge instead of teaching or of developing such discipline of mind as will enable the student to acquire knowledge by his own efforts.

A good instructor is able to talk on his feet so that he can be heard and correctly understood, and has such human qualities as to enthuse his students in the subject he is teaching.

3. TEACHING METHODS. Failure on the part of a student to grasp a certain subject is usually laid at the door of the student Careful observation will show that such failures can often be traced to poor teaching methods or to incompetent instructors.

The best teaching methods lay the greatest emphasis at all times upon teaching men and not subjects. Every effort should be made to build upon a student's ability, knowledge and experience, while stimulating his imagination and developing judgment and leadership.

Instruction cannot be efficient unless the student is interested in what he studies. To interest a student in his studies, such studies must be practical and must be imparted so that the student can see the application of the subject he studies. In scientific and engineering courses laboratory instruction should be so correlated to the classroom work that the student learns to do by doing. In the classroom, instruction lectures should be eliminated or reduced to a minimum, and in their place the recitation method should be used in connection with practical problems, so that principles are fixed in the student's mind.

In classroom work not more than fifteen men should be assigned to one instructor, and the instruction should be planned so that each student recites every day. To save the student's time, problems bearing upon the lesson should be written out by the instructor before the time of the class and handed to each student as he enters the classroom. The student solves the problem on the blackboard, and the instructor, by watching the student's work can find out the weak points while imparting instruction to each indi-

vidual student. Not more than one-third of the classroom time should be devoted to the solution of the problems on the blackboard, and the remainder of the time should be utilized in oral discussions. In conducting an oral recitation the instructor first asks the question before the whole class, and then calls upon one student to give the answer. This method keeps the whole class alert, which is not the case if the instructor calls upon the student and then asks him the question. It is poor practice for the instructor to keep his textbook open during a recitation, except when the students are required to do the same in order to call attention to an illustration or to a table of figures.

The subject matter should be carefully planned and well organized. The instruction process should consist of a series of steps or exercises, taken in order from the simple to the complex. Textbook or printed notes should be used in every course, and the lesson assignment should be worked out in advance and committed to writing. Copies of the lesson schedules should be given to each student or posted, so that oral directions can be reduced to a minimum, thus conserving the student's time.

Definite organization of instructional staff and of teaching material combined with superior instructors will always result in efficient instruction.

A Review of Literature on the Rusts of Oats, with Notes on Their Distribution in the United States.*

John H Parker,
Professor of Crop Improvement, Kansas State Agricultural College

INTRODUCTION.

Oats are not only one of the important cereals of commerce, but are largely grown and used in almost every agricultural region as a feed crop. Thus the acreage and yield per acre are of local as well as national importance. Any factor or factors which operate to reduce the yield per acre in any locality, therefore, deserve to be carefully studied, always with the object of gaining that knowledge which will be useful in improving or maintaining the yield of the crop.

The rusts of oats must be counted as limiting factors in oat production, not in all localities nor in every season, but nevertheless causing immense average annual losses. A considerable amount of work has been done in this and other countries in the attempt to increase our knowledge of these parasites and their host relationships, and thus to make possible the utilization of effective control methods.

In connection with the writer's work on the problem of rust resistance in oats it seemed desirable to assemble the literature not only of that particular problem, but of the various other phases of experimental work on the oat rusts. This summary of the important literature should be of interest to

* The material for this paper was prepared during the year 1915-1916, while the writer was doing graduate work at Cornell University. Thanks are due the departments of plant pathology and plant breeding for library and other facilities furnished. The Plant Disease Survey and members of the staff of the Office of Cereal Investigations, Bureau of Plant Industry, United States Department of Agriculture, and of the state experiment stations, contributed the notes on distribution of oat rusts in the various states.

plant pathologists, plant breeders and agronomists who are working on any phase of oat production, and particularly to those experimenters carrying on rust problems.

The notes on geographic distribution, relative to soil and climatic factors, damage, etc, should also be helpful to those workers who must be familiar with conditions in other states as well as in their own.

Carleton (6) discusses the distribution of oats in this country by districts, and in many of these districts mentions rust prevention as one of the needs The varieties adapted to each district are listed and described, a general classification of varieties is given, and the origin and present world distribution of the crop are discussed

For further information on the oat crop in the United States, including descriptions of varieties, methods of culture and other agronomic problems, reference may be had to the publications of the United States Bureau of Plant Industry and to those of the several state agricultural experiment stations.

The two rusts of oats are distinct in appearance, distribution, life history, and in their effect on the crop, hence the literature dealing with the two species has been for the most part kept separate, and is so arranged in this paper.

THE CROWN RUST OR LEAF RUST OF OATS

Puccinia lolii Niels f sp *avenæ*

= *Puccinia coronifera* Kleb
= *Puccinia rhamni* (Pers) Wettst

This rust having its æcidial or winter stage on species of *Rhamnus* (buckthorn) has been one of the well-known forms since the time of De Bary, who worked out its life history at about the same time that he proved the heterœcism of the black stem rust of grains

As early as 1791 Gmelin described *Æcidium rhamni* on species of *Rhamnus* In 1801 Persoon listed what was probably the same rust as *Æcidium crassum,* while Schumacher in 1803 described two distinct æcidial forms—*Æcidium frangulæ* and *Æcidium catharticæ.* Lamarck and De Candolle, in 1805, mentioned several forms—*Æcidium, rhamni-alpina, Æcidium crassum* on *Rhamnus frangula,* and *Æcidium irregulare* on *Rhamnus cathartica* Link, in 1825, described two cæomas which probably should have been referred to this same group.

Corda (10), in 1837, first described the *Puccinia* stage, on a plant which he determined as *Luzula albida,* a rush. This was evidently a wrong host identification, for no crown rust has since been collected on *Luzula.* The name (*Puccinia coronata* Corda) which he applied, however, has been very commonly used to include the various crown rust forms of grains and grasses, and is still so used by many writers.

In 1854 Westendorp used the name *Puccinia coronata* var. *lolii* Bellk., and in 1862 Preuss published the name *Puccinia sertata.* On the basis of culture work, Nielson (40), in 1875, separated the old *Puccinia coronata* of Corda into two forms; to the one having its æcidium on *Rhamnus cathartica* he gave the name *Puccinia lolii,* retaining the old name for the form producing its æcidium on *Rhamnus frangula.*

In 1862 Plowright (37) gave a fairly complete description of this rust of oats, an abstract of which is here given:

Puccinia coronata is one of our most interesting species on account of the form of the teleutospores. The uredo consists of orange spores more spherical in form than those of *P. graminis*. Is common on cultivated oat, occurs in large patches, it being in this respect quite distinct from uredo of *P. graminis* or *P. rubigo vera*. It is not uncommon on *Holcus lanatus*, *Lolium perenne*, *Dactylis glomerata*, *Avena sativa*, and *A. elatior*.

Teleutospores are subcuticular, cylindrical in form, but wider above than below. Provided with very short stalks inferiorly, but the upper division of each spore is crowned with a variable number of well-developed, curved processes, hence the name.

Æcidium of this *Puccinia* is the *Æcidium crassum* of Persoon. Common upon *Rhamnus frangula* and *R. cathartica*. Æcidium spores placed upon oats give rise in 15-20 days to uredo generation.

In 1889 (38) Plowright published a more extended description of this rust in his well-known monograph of British rusts and smuts.

Klebahn (29) in 1892 performed a series of inoculation experiments, and very definitely established the fact that two distinct groups of crown rusts must henceforth be recognized; for the one forming æcidia on *Rhamnus frangula* he retained the name of *P. coronata* Corda, applying the name *P. coronifera* Kleb. to the one producing æcidia on *Rhamnus cathartica*. In this latter group belongs the "form species" *avenæ*, the crown rust of oats.

As Magnus (32), in 1912, has pointed out, however, Nielson (1875) had already made this same separation, and had used the name *Puccinia lolii*, which must then, according to priority, be used instead of the name *P. coronifera* as later (1892) used by Klebahn. Grove (22), McAlpine (31) and Sydow (47) use the name *P. lolii* f. sp. *avenæ*, while Eriksson (14, 13), Pole-Evans (16), Fischer (18), Klebahn (30) and others use the name *P. coronifera* Kleb.

The following abstracts are included because of their general interest in the matter of nomenclature, description, distribution, etc.

McAlpine (31) states that the crown rust of oats has been collected on *Avena sativa* and *Avena fatua* in Australia, and often occurs with the stem rust.

Grove (22) considers the two forms of crown rust rather as biologic forms than as species, and states that host differences and a few minor morphological characters are the only distinguishing features. Plowright is said to have surmised that there were two crown rusts. As hosts, Grove lists: *Rhamnus cathartica*, on which æcidia are produced in May and June; various grasses; and of the cereals, only oats, *Avena fatua*, *A. pratensis*, and *A. sativa* are attacked, considerable injury sometimes resulting.

Pole-Evans (16) writes as follows regarding the crown rust of oats in South Africa:

OCCURRENCE. I have evidence to show that the crown rust of oats does considerable damage to the oat crops in the Transvaal. This rust appears later in the season than *P. graminis*. The æcidium has not been definitely shown in this country.

HISTOLOGY. The appressorium formed by this fungus is very similar to that of *Uredo graminis*, but the substomatal vesicle is of very different shape and gives rise at once to two infecting hyphæ. The haustoria are of large size and cylindrical in shape. The pinhead types so common in the case of *P. graminis* are here rarely met with.

In another paper Pole-Evans (17) writes as follows regarding his work on the crown rust:

In my previous report I expressed the opinion that I thought it quite likely that the æcidium on *Rhamnus prinoides*, first found by MacOwan in this country, might be

with the crown rust of oats; in fact, *Rhamnus prinoides* is quoted by Saccardo as being one of the hosts of this rust. In Europe this rust is heterœcious on *Rhamnus catharticus,* while in the United States *Rhamnus lanceolata* bears the æcidium. Consequently, every endeavor was made to obtain specimens of the æcidium on *Rhamnus prinoides.*

With material gained from Cape Colony, I at once set about inoculating a number of oat plants, but on the following day, on examining some spore material which had been sown in watch glasses of distilled water to serve as controls, I was surprised to find that the æcidiospores had not germinated as ordinary æcidiospores, but as teleutospores. On further examining the nature and character of the fungus, I came to the conclusion that it undoubtedly belonged to the genus *Endophyllum,* and has nothing whatever to do with *Puccinia coronata.* I propose to describe and name this fungus as *Endophyllum MacOwanianum,* n. sp. Naturally, none of the inoculated oats developed any pustules.

Saccardo (41) in volume 7, lists the following as æcidial hosts for *Puccinia coronata: Rhamnus cathartica, R. frangula, R. alpinæ, R. saxatilis* and *R. prinoides.*

Avena (oats) and many grass species are listed as hosts of the uredospore and teleutospore stages. It would seem that he did not at this time recognize the two distinct forms. However, in volume II *Puccinia coronifera* Kleb is described as occurring on *Rhamnus cathartica* (æcidial stage) and on *Lolium, Festuca, Holcus* and *Avena* (oats) in the unredospore and teleutospore stages.

Eriksson and Henning (12) give the following account of their studies on the crown rust of oats:

Puccinia coronata Corda.

1. The "resting stage" of the fungus, in winter There is no possibility of the living over of rust mycelium, for only spring oats are grown. Grasses infected with this rust produced no new uredo pustules during the winter, hence this rust does not live over winter by this method.

2. The first stage of the fungus, the "promycelial" stage. Teleutospores germinate only after overwintering in the open

3. From teleuto material from *Avena sativa* positive infection results were secured only on *Rhamnus cathartica.*

4. The second (æcidial) stage resembles closely in manner of appearance that of the stem rust on *Berberis.*

5. The third (uredo) stage was observed on oats in 1892 and 1893 in July and August Uredospores usually germinate easily.

6. Infection trials were made with uredospores on oats with material collected on *Calamagrostis, Alopecurus, Melica,* and from oats; only the latter gave positive results.

7. *Puccinia coronata* is a "collective" species:

   Series I. *P. coronifera* Kleb Æcidium on *Rhamnus cathartica* f sp. *avenæ* on *Avena sativa,* and, according to Nielson, on *Lolium*

   Series II. *P. coronata* Æcidium on *Rhamnus frangula*

   Series III. *P. coronata* var. *himaliensis.* Æcidium on *Rhamnus dahurica.*

8. The fourth (*Puccinia* = teleuto) stage. In general the teleutospores are covered by the epidermis, but open sori have sometimes been observed on certain grasses.

9. The economic importance of this rust is not, generally speaking, very great. There is only in one locality of West Sweden a report of the abundant appearance of crown rust of oats (1890).

Eriksson (14) adopts Klebahn's name for the crown rust of oats, and gives the following account of his own observations and studies.

In 1894 the following specialized forms of crown rust were recognized:

Series I. Æcidium on *Rhamnus cathartica* = *Puccinia coronifera* Kleb. 1. f. sp. *avenæ* on *Avena sativa.* (2, 3, 4,) f. sp. on grasses.

Series II. Æcidium on *Rhamnus frangula* = *Puccinia coronata* Corda (5) f. sp. on *Calamagrostis.*

Series III. Æcidium on *Rhamnus dahurica* = *Puccinia coronata* var. *himaliensis.*

Series IV. Æcidium unknown (wanting?).

Klebahn later established the correctness of the conception of f. sp. *avenæ*. At this time, however, it was not certain that the forms so set off by their uredo infections would remain so through the æcidial stage. Further infection studies of the forms on grasses and oats were needed. These have been performed during 1895 and 1896.

Teleuto material from oats caused infection on *Rhamnus cathartica, R. grandiflora, R. alnifolia,* not on *R. frangula*. Successful infection of *Rhamnus cathartica* from oats (teleuto material) has been repeatedly secured by the writers, as well as by Klebahn.

All the trials so far made go to prove that every form of crown rust forms its æcidia on *one* (not both) of the groups of *Rhamnus* species.

It is, then, proper now to follow Klebahn in giving specific rank (*P. coronifera*) to those forms producing æcidia on *Rhamnus cathartica,* and (*P. coronata*) to those with æcidia on *R. frangula*. The two forms are also set off by observed morphological differences:

1. The teleutospore sori of *P. coronifera* have a tendency to form a circular group about the open uredo pustules, and to remain for a long time, covered by the epidermis; while in the case of *P. coronata* the teleuto sori are more irregularly distributed, and are often open, *i. e.*, not covered by the epidermis.

A further morphological distinction perhaps also exists in the more abundant occurrence of paraphyses in the uredo stage of the *P. coronata* forms.

Certain it is, as in the stem rusts, that sharply fixed groups exist in the uredo stage. Certain results seem to indicate (in the case of the crown rusts) that the æcidial stage may sometimes act as a bridging host.

The following are the forms established

I. *Puccinia coronifera* Kleb Æcidium on *Rhamnus cathartica* F sp. *avenæ* on *Avena sativa* (2, 3, 4, 5, 6) on various grasses.

II *Puccinia coronata* (Corda) Kleb. Æcidium on *Rhamnus frangula* 1, 2, 3, 4, 5, f sp on various grasses

There are certain grass-inhabiting forms whose æcidial stage is not yet known, and whose correct systematic place is therefore doubtful.

. . . .

There have been, then, so far carefully studied no less than thirteen specialized forms of crown rusts, six belonging to *P coronifera*, five to *P. coronata,* and two whose correct place is not yet known, in addition to numerous crown rusts as yet not at all carefully studied. For these it is well (provisionally) to retain the old collective name *P coronata*. If one compares the specialization of the crown rusts with that of the stem rusts, certain differences are evident In the stem rusts (excepting the form on timothy) there are only six specialized forms recognized, occurring on eighteen species of grasses Some of these six forms occur on grasses belonging to different genera—for instance, the rye rust, which is found on seven grasses, and the stem rust of oats, which occurs on eight grasses, including *Avena sativa, A. elatior, A. sterilis*.

How different are conditions in the crown rusts! In the case of *P. coronifera* there are no less than six specialized races, occurring on eight grasses; and five such in the case of *P. coronata*.

The question occurs, What are the causes of these differences in specialization in two groups of rusts where so many analogies exist?

This question must for the present remain unanswered, for we are just beginning to acquire an understanding of the phenomenon of specialization This specialization reaches gradually the ultimate condition where a rust is strictly limited to *one* host

Barberry shrubs are much more common in Sweden than are buckthorns, and as a rule are more abundantly infected with the æcidial stage of rust. The influence of the æcidial hosts has no doubt played a part in the specialization. The crown rusts, then, must more often do without the æcidial stage, and this, perhaps, has resulted in their separation into so many biologic forms.

The stem rust of oats is capable of living on a large number of distinct hosts, and this is taken as an indication of its high "vitality." This view is in agreement with other characteristics of this same rust, viz.:

a. Usual good germination of the spore forms.
b. Numerous infections secured.
c. Destructive effect on the oat crop.

. . . .

In Sweden the stem rusts occur (destructively) not only on the four cereals, but on

nearly 100 other grasses It is quite otherwise with the crown rusts. These have as hosts only a limited number of grasses, and of the four cereals only oats is attacked. The crown rusts occur only in certain localities and cause (at least in middle Sweden) no injury worth mentioning

It is without doubt true that these facts are correlated with or dependent on the sharp specialization to which the crown rusts have attained The spread of crown rusts from one grass species to another is a very much more unusual occurrence than in the case of the stem rusts It would even appear that the occurrence of crown rusts depends on (1) the presence of the æcidial host, (2) on the adjacent cultivation of grasses of the same species, and indicates, with the less frequent good spore germination, a lower "vitality" for the crown rusts than that which exists in the stem-rust group

The crown rusts have not often been seen to occur abundantly in Sweden It is rather the rule that isolated grasses will be infected, while others of the same species, even though only a few feet distant, will remain free of rust The crown rust seems, therefore, to be best adapted ("at home") in more southern regions Thus Rostrup reports crown rust of rye grasses as abundant and destructive in Denmark in 1884, 1885 and 1886 Cases are also known where the crown rust of oats has been very destructive, as in certain parts of Sweden (Tanum, 1890, and Holstein, 1891)

Observations in 1895 have also been made on the injurious occurrence of crown rust on oats At Svalof (late in July) it was as abundant on many oat sorts as the stem rust, both being in the early stages of development

The pustules of crown rust occurred only on the leaf blades, those of the stem rusts mostly on the sheath

A still heavier infection of crown rust was observed (second week of August) at Gottingen This rust infection was present on all oat sorts, more especially on the most vigorous plants, where it was as abundant and destructive as the stem rust often is, in Sweden Not only the leaf blades were entirely covered with pustules, but also the lower leaf sheaths, where stem rust itself is characteristically only sparingly present

Eriksson (15), after further work, wrote as follows

Comparison of my own results with those of Klebahn, Carleton and other foreign workers has shown us another case where the specialization of a parasite is quite different in two different countries

NOTE —The weak limitations of the crown-rust fungus in America stand in sharp contrast to the sharply fixed European forms

I. *Puccinia coronifera* Kleb f sp *avenæ* Trials in Sweden, Germany and Austro-Hungary have conclusively shown that *Avena* (*sativa*) is the *only* host for this particular form

Near Stockholm, and as well in other parts of Sweden, this rust appears in different years with very different degrees of intensity, and in general is much less common than the stem rust There are years when the crown rust cannot be found at all in the experimental field It was, however, very abundant here in 1890, less so in 1892 and 1893, as well as in 1895 None at all was observed either in 1896 or 1897, while in 1898 it was again very abundant

These varying appearances of the rust in different years cannot be due to the fact that in some years the alternate host was absent, for there were always shrubs of *Rhamnus cathartica* within 500 to 1,000 meters of the experimental oat fields, but these bushes were often nearly or entirely free from rust

Evidently the crown rust finds in middle and northern Sweden the limit of its distribution, *i. e.,* favorable habitat Its vitality is relatively lessened, and only when conditions are very favorable does it reach abundant development

Conditions are quite different on the continent of Europe In Germany the crown rust is of much greater importance than in Sweden, even perhaps causing greater injury to the oat crop than the stem rust.

Muhlethaler (33) has conducted extensive infection trials with a large number of crown rusts occurring in Switzerland, and has cleared up some of the obscure points which still remained after the work of Klebahn and Eriksson. Æcidial material from *Rhamnus frangula, R. cathartica, R. alpina* and *R. pumila* was used, as well as uredospore and teleutospore material from various grasses.

The following forms are recognized:

1. *Puccinia coronifera* Kleb.

Æcidia on *Rhamnus cathartica* . . } of the group Cervispina.
Æcidia on *Rhamnus utilis* host . }
Æcidia on *Rhamnus dahurica* . }
Æcidia on *Rhamnus saxatilis*
Æcidia on *Rhamnus imerctina* host.

I f sp *avenæ* (2, 3, 4, 5, 6, 7, 8, 9), other f sp on various grasses

2. *Puccinia himalensis* (Barcl) Diet.
3. *P alpinæ* coronata.
4. *P. coronata* (Corda) Kleb.

Æcidia on *Rhamnus alaternus* } group Alaternus
Æcidia on *R californica* }
Æcidia on *R billardi* }

Æcidia on *R frangula* . } group Frangula
Æcidia on *R purshiana* }
and on *Rhamnus imeretina* host

5 *Puccinia coronata* Corda s lat f. sp meticæ Æcidial stage unknown.

The crown rust of oats in the United States has quite commonly gone under the old name of *Puccinia coronata* Corda There is great need of some careful and extensive culture work, for the relation of the numerous crown rusts of grasses to the form on oats is not thoroughly understood, nor are all the possible æcidial connections of these rusts definitely known

The following species of *Rhamnus* occur in the United States, with ranges as indicated

Rhamnus alnifolia L'Her 1788
Range British Columbia to Maine, southward to California, Wyoming, and New Jersey Indigenous

Rhamnus purshiana D C 1825
Range British Columbia to Idaho and California

Rhamnus smithii Greene 1896
Range Southern Colorado

Rhamnus cathartica L
Range European Introduced to America, where it is used in New England, the Middle states and Ontario as a hedge plant Has escaped from hedges and become naturalized

Rhamnus lanceolata Pursh
Range In moist soil, Pennsylvania to Iowa, Nebraska, Alabama and Texas Indigenous

Rhamnus caroliniana Walt
Range In wet soil, Virginia and Kentucky to Kansas, Florida and Texas

Rhamnus frangula L
Range In bogs, Long Island and New Jersey Reported from Ontario. Naturalized from Europe

Of these the writer has found records of the occurrence of the æcidia of crown rust of oats only on *R. cathartica*, *R. lanceolata*, *R. alnifolia* and *R. caroliniana*. Prof. H. S. Jackson, formerly of the Oregon Agricultural College, states (see "Notes on Oats and Oat Rusts from Oregon," in this paper) that "*R. purshiana* is commonly infected with an æcidium," but from the results of Muhlethaler (above cited) it would seem doubtful whether this species is a host for our crown rust of oats. *Rhamnus frangula* is not as commonly used for a hedge plant as *R. cathartica*. Little is known of the relation of any of our crown rusts to this possible winter host.

Pammel (35) gives *Rhamnus frangula* as a host for the crown rust of oats, and says: "It is found in several places in Iowa, but it is certainly not common."

Pammel (36) further states that the two rusts of oats have been so serious during the last few years that the crops have been very light. The spraying experiments were repeated in 1893, but there were no appreciable differences observed between the check and the sprayed plats.

Although the identity of our American forms is not as firmly established as would be desirable, it is thought the evidence is sufficient to warrant the use of the nomenclature adopted here; that is, to drop the old collective name, *P. coronata,* and to use either *P. coronifera* Kleb., or, if the rules of priority are strictly followed, the name here used (*Puccinia lolii* Niels.) is the proper one.

Arthur does not use either of these names, but goes back to the specific name used before Corda's description of the Puccinia stage, *i. e.*, to the binomial *Æcidium rhamni,* and thus derives the name he now uses, *Puccinia rhamni* (Pers.) Wettst.

The following abstracts from accounts published in America of the occurrence, distribution, relationships and other characters of the crown rust will give a fairly good idea of the present state of knowledge of crown rust in this country:

Thaxter (48) reported in 1889 that both the crown and the stem rust had been injurious to oats in Connecticut, the first-named rust being the most destructive.

Kellerman (28), in connection with his report on spraying to prevent rust, makes the following statement regarding the crown rust of oats

On July 2 the oat plats showed much red rust (*P. coronata*) Adjacent fields of oats were likewise affected. Later examination revealed no difference in the amount of rust in the treated and untreated plants They were all equally affected, with the possible exception of the Bordeaux treatment, where there seemed to be, perhaps, a little less rust on the stems than in the other plats.

Hitchcock and Carleton (25), 1893, report that the æcidial stage of the crown rust of oats is formed on *Rhamnus lanceolata* and on some other species of the order Rhamnaceæ.

In a second report (26), 1894, they state that while in 1892 the crown rust was the predominant one on oats, with very little of the stem rust, in 1893 *none* of the former species was found on any host in the vicinity of Manhattan, Kan., while the latter (stem rust) was very abundant.

Underwood and Earle (50) reported "*Puccinia rubigo-vera*" on oats (*Avena sativa*) as having been collected (1890) in Lee county, Alabama, by Professor Atkinson. The rust referred to is probably the crown rust.

Henderson (23), 1898, states that so far the crown rust is very rare in Idaho.

Arthur and Holway (1) in 1898 published a detailed description of the crown rust, which is given below:

Puccinia rhamni (Pers.) Wettst. 1885 in Verhl. Zoöl. Bot. Wien., 545.

Hosts:

II. *Avena sativa, fatua.*

I. *Rhamnus lanceolata.*

R. alnifolia.

Æcidium crassum Pers.

Syn. *Æcidium rhamni* Pers., 1791.
Puccinia coronata Corda, 1837.
Probably also *Æcidium pulcherrium* Rav. on *Berchemia*, as described by Berkeley, N. A. Fungi, Grev. 3, 61.

I. Æcidia on somewhat thickened definite spots on lower side of leaf, occasionally causing considerable distortions, especially when on young fruit and shoots; at first orange, becoming nearly colorless with age; margin erect, somewhat erosed; æcidiospores orange yellow, becoming pale yellow with age, isodiametric or somewhat elongated, polygonal; 16-24 microns in diam.; wall thin, minutely granulose.

II. Uredo sori of medium size, oblong to linear, on both leaf surfaces, occasionally on sheaths and stems; scattered, rarely confluent, but sometimes clustered, soon naked; orange-colored; ruptured epidermis prominent. Uredospores globose, some admixture of obovate globose; 22-30 microns in diam ; wall colorless, thin, obscurely echinulate; pores four or more, scattered. Contents orange when fresh, becoming yellow on drying.

III. Teleutospore sori on both leaf surfaces, but more abundant on under side of blade; less common on sheaths and stems, scattered; irregularly oblong, partly fructiform, covered with the persistent epidermis, grayish black. Teleutospores subclavate to linear oblong, 35-60 x 15-18 microns, slightly or not constricted; wall thin, smooth; apex not much thickened, but produced into finger-form projections, either erect or more or less inclined, corona like; base somewhat narrowed; pedicel very short or obolescent.

This is a species the limits of which are not easily defined. Arthur secured typical uredo on oat leaves by sowings made (1898) from æcidia on *Rhamnus lanceolata*.

We have no opinion at present to offer as to Klebahn's separation of the two forms. It is believed the material at hand is properly referred to the one species, *P. rhamni*.

Carleton (5) in 1899 published the following observations on crown rust: *Puccinia coronata* Corda.

Physiological Relations. The most distinct of all the cereal rusts, superficially and microscopically very different from the black stem rust. The uredospores are, however, similar (in shape) to those of the leaf rusts of wheat and rye.

Although the rust does not seem to occur in nature on very many wild grasses, several of these were infected with it when inoculated in the greenhouse.

Successful on—
Oats:
Siberian.
Black Tartarian (doubtful).
Avena fatua.
Nackter Kleiner. Fahmen.
Etampes.
Fenton's Rust Proof.
Avena pratensis.
Ligowa.
Dun.
Avena sterilis (only 1 or 2 spots).
Usual incubation period is 7 to 10 days.

Additional hosts: *Avena sativa patula, A. sativa orientalis, A. sativa nuda.*

Other species of *Avena* that will probably be found to act as hosts are: *Avena fatua A. pratensis, A. hookeri, A. sterilis.*

Grasses:
Hoddeum murinum (1 or 2 spots).
Phleum pratense.
Dactylis glomerata.
Aira cæspitosa (1 or 2 spots).
Holcus mollis (doubtful).
Eatonia sp.
Kœleria cristata.
Anthoxanthum odoratum.
Festuca sp.
Alopecuris alpestris.

Grasses—*Concluded*
Phalaris arundinacea.
Trisetum subspicatum (1 or 2 spots)
Brizopyrum siculum (doubtful)
Phleum asperum.
Poa annua (1 or 2 spots)

It is suggested (and this was evident from trials made on more mature plants) that results differed from field conditions in that (1) young plants were used and (2) greenhouse conditions were more favorable for rust propagation

Certain plants which had been successfully infected when quite young were inoculated at a more advanced age The result was that infections did not occur at all or were very slight and evidently took place with difficulty.

Infections on grasses (using uredo from oats) are recorded, but none on oats using uredo from wild grasses

Æcidial material from *Rhamnus lanceolata* resulted in the infection of—
Oats
Phalaris caroliniana.
Arrhenatherum elatius

Occurrence and Distribution The crown rust seems to be quite analogous to the leaf rust of wheat It is the more common of the two rusts of oats in the United States Compared with the stem rust, it seems to be especially prevalent in the Atlantic and southern coast states, where the urego stage is very likely able to live over the winter

Apparently the crown rust is not as constant in its occurrence from year to year as the leaf rust of wheat, though the writer is not certain of any instance where it was entirely absent during the entire summer

Although one of the most prominent rusts in the United States, it seems strangely enough to be rather insignificant in most other countries

The writer knows of no instance where it could be proved that this rust caused any really serious damage to oats, under ordinary conditions, when the black stem rust was not also present, but nevertheless it is quite possible that it may occasionally cause considerable injury In any event, the crown rust seems to be of more economic importance in the United States than in most other countries

Clinton (9) in 1903 reported the crown rust as common on the leaves of oats.

Carleton (7) in 1904 reported further work on the crown rust of oats as follows, and in this publication used the name *Puccinia rhamni* (Pers.) Wettst

In the same season in which Doctor Arthur obtained infections on oats from the æcidium of *Rhamnus lanceolata*, the following experiments were conducted

August 30, 1897. Inoculations from crown rust on *Phalaris caroliniana* to oats resulted September 7 in a good infection, to orchard grass, poor; to wheat, none

September 1· Inoculations made on wheat and rye, but with no result

December 11. Inoculations were made (from uredo material of crown rust found on *Arrhenatherum elatius*), on oats and rye, good infection resulted on the oats in twelve days, none on the rye.

February 16 Further inoculations on oats with the rust from *Phalaris* gave again a good infection in nine days.

Rhamnus lanceolata at Weeping Water, Neb, is often badly rusted with an æcidium.

June 1 and 2 Inoculations were made with these acidiospores on oats and *Phalaris caroliniana,* resulting in a successful infection of *Phalaris* on June 14 and of oats on June 18.

These experiments prove the connection of the æcidial form of *Rhamnus* with the crown rust of oats, and show also that *Phalaris caroliniana, Arrhenatherum elatius*, and probably orchard grass, *Dactylis glomerata,* are also hosts for the crown rust

Christman (8) studied the wintering of oat-crown rust at Madison, Wis., during the winter of 1902-1903, and his conclusions were as follows·

It is plain that in the latitude of Madison, and with a period of three months during which the temperature scarcely rises above the freezing point, viable uredos may be obtained at practically any time during the winter.

An oat plant was covered. (snow and under glass) and the development of "flecks" watched during the winter, and pustules (opening the epidermis) formed. (It seems probable

that uredos and mycelium of the crown rust are at least as resistant as the oat plants on which they grow.) Uredos from oats were germinated as late as January 26, and it seems probable that the mycelium would have withstood the remainder of the winter if the host could have been kept alive. In cooler weather of spring the incubation period is three to four weeks. Spores may be carried in fairly large numbers by the wind.

At Madison the uredos may remain dormant for long periods without losing their vitality, but these "old" spores may very likely play little part in producing spring infection, since on the first warm days the mycelium produces new pustules and a fresh crop of spores.

As the severity of the weather must affect the amount of healthy host tissue that survives the winter, it must limit the amount of mycelium and so the number of uredos at hand in the spring, and is probably one of the chief factors in determining the violence of early outbreaks of the rust.

Bolley and Pritchard (3) in 1906 state that oats are generally attacked by the early lemon-yellow leaf rust (crown rust).

Olive (34), in 1908, gives the following note as to the occurrence of crown rust of oats in South Dakota:

This rust has its spring stage on the buckthorn, which is a well-known plant and is very commonly used for ornamental hedges throughout South Dakota, being even much more employed for this purpose than barberry. During this past spring hedges of this plant have been everywhere viciously attacked by the yellow cluster-cup stage, stunting the leaves and deforming and twisting the young stems. We should consequently expect the rust on oats to be especially virulent during the wet season, especially if further favorable conditions for the rust are furnished by a series of warm, muggy days.

Control measures suggested are:

1. Drainage.
2. Destroy æcidial hosts
3. Destroy wild grasses harboring the rust.
4. Selection and breeding of immune forms.

Selby (43) reports crown rust common on oats in Ohio, usually prevalent during the rainy harvest weather and more or less in evidence at all times.

Warburton (51) writes as follows concerning the rusts of oats:

The rusts are easily recognized by the appearance of irregular roughened areas on the leaves and stems, which at maturity discharge large numbers of red or black spores The most common rust of oats is the crown rust, usually known as the red or leaf rust, though the stem rust also commonly occurs on this grain. The crown rust does not injure the crop as seriously as the stem rust, which, when it occurs, makes its appearance a few days later than the crown rust and is likely to do serious damage. These rusts take the food from the stems and leaves of the oat plant, that would naturally go to the development of the grain, which is, as a result, light and shriveled. No accurate estimate of the damage done by the rusts can be made, but it is probably even larger than that done by the smuts.

There are no known means of combating the rusts when they occur. The damage may be somewhat reduced, however, by early planting or by the planting of varieties which mature before the black rust develops, and by planting on well-drained land, as moisture is essential to the development of rust. The red rustproof oat is quite resistant to rust in the South, where the disease is usually prevalent, but is much less resistant in other sections. Drilled oats are less liable to injury from rust than those sown broadcast, as light and air can penetrate between the drill rows. Rank growth resulting from rich soil, excess of nitrogenous fertilizer, or abundant moisture, also favors rust.

Reed and Holmes (41) in 1911-1912 made a study of the winter resistance of the uredospores of the crown rust of oats at Blacksburg, Va., and reported on their work as follows:

This work was begun in the fall of 1909 to determine whether the crown rust of oats can be carried over the winter by the uredospore, at Blacksburg. Located in an elevated portion of the intermountain valley, at an elevation of 2,200 feet above sea level, the winters here are much more rigorous than in many other parts of the state. Carleton has expressed the opinion that the uredospore of this rust hibernates successfully in the warmer parts of the United States.

The crown rust causes little damage as a rule, although it is more common than its more destructive relative, *P. graminis avenæ*, the stem rust.

The observations here reported were made upon two plats of oats; one was an area of volunteer (summer) oats, the other was a plat of winter oats. The plants on the former plat were dead by December 1, but the plants on the other plat remained green throughout the entire winter The plat of volunteer oats was designated "A," the winter oats as plat "B." In November the tufts of oats in each plat that were badly infected with rust were marked with a stake so that material could be easily secured from the same locality from month to month.

The viability of the spores was tested in a modified Van Tieghem cell, using the "hanging drop" method, at room temperature (between 18° and 24° C.).

The results of the tests are shown in tables XIV and XV.

TABLE XIV. Germination tests of uredospores of *P. coronata* from plat "A."

Date. *1909.*	*No. of tests made.*	*Per cent of germination*	*Remarks.*
Nov. 1	5	100	
Nov. 15	5	85	
Dec. 1	5	40	All plants of the plat were dead at this time
Dec. 15	5	25	
1910			
Jan. 5	5	20	
Jan 15	5	25	
Feb. 1	3	15	
Feb 15	5	20	
Mar. 1	3	5	The germination in this case was rather doubtful
Mar. 15	5	0	
April 1	5	0	

TABLE XV. Germination tests of uredospores of *P. coronata* from plat "B"

Date. *1909.*	*No. of tests made*	*Per cent of germination*	*Remarks.*
Nov. 1	5	100	
Nov. 5	5	90	
Dec. 1	5	60	
Dec. 15	5	35	All growth seemed to cease
1910.			
Jan. 5	3	10	
Jan. 15	3	0	
Feb. 1	5	10	
Feb. 15	3	10	
Mar. 1	5	20	Growth began to be resumed
Mar. 15	5	25	
April 1	1	50	Oats in a growing condition.

The figures presented in these tables, brief though they are, show that the uredospore, under natural climatic conditions, may and does retain its vitality on winter oats and to a limited extent upon volunteer summer oats. On winter oats it seems that the crown rust has an enduring mycelium and produces uredospores during much of the winter. In table XV the results obtained during January and February are interpreted to mean that the fungus mycelium had ceased to produce spores, and that those still attached to the surface of the plant were losing or had lost their vitality. When conditions ensued which were more suitable for growth, the mycelium began to produce spores, and on April 1 it appeared that 50 per cent of them were capable of germination. Johnson has reported that the minimum temperature for the germination of the uredospores of this fungus is 7° to 8° C. Somewhat similar conditions seemed to exist in the case of the volunteer oats which did not survive. There the vitality of the uredospores seemed to fall off in much the same way, but since the host plant was dead the mycelium did not begin to form new crops of spores with the advent of warmer weather.

The relation of spore vitality to temperature is, of course, more or less obvious. Some records were made from the meterological observations taken at Blacksburg. It was noted that in a general way the percentage of viable spores on the winter oats (plat "B") corresponded to the temperature curves. Although the oats ceased to grow after December 15, the fungus appeared to be in condition to furnish viable spores practically all winter. In the case of spring oats (plat "A") the percentage of viable spores dropped, during the first six weeks, nearly parallel with that of plat "B," but after February 15 it fell off still more

rapidly, while the other curve rose. It would appear then that where the host plant lives over winter that temperature is the principal factor limiting spore germination of this rust. Where the host plant dies, time appears to be the more influential factor limiting spore germination.

Davis (11) listed (1914) the crown rust on oats, *Avena sativa,* and on *Calamagrostis canadensis* and *Dactylis glomerata,* both uredospore and teleutospore stages, and the æcidial stage on *Rhamnus alnifolia* and *Rhamnus cathartica.*

Burnham and Latham (4) in 1914 reported the occurrence of the æcidial stage of crown rust on leaves of *Rhamnus cathartica,* and the uredospore stage on leaves of *Avena sativa.*

Fromme (21) in 1914 made a study of the influence of light on the germ tubes of uredospores of the crown rust, and found a negatively heliotropic reaction, *i. e.,* the germ tubes grew away from the light. This fact may possibly have a bearing on certain phases of infection; that is, on the stimuli which are responsible for the stomatal entrance of germ tubes.

Freeman and Johnson (20), in 1911, state:

The crown rust almost invariably accompanies the stem rust and is probably the most destructive of the leaf-rust group. The crown rust often occurs on the leaf blades, commingled with the stem rust, making it difficult to determine how much of the damage is due to each The crown rust is, however, seldom found on the spikelets or spikelet stems.

Oat rusts are found extensively only east of the dry belt of the Great Plains region, with the possible exception of eastern Oregon and Washington

In the gulf coast states, except northern Texas, and in Georgia and South Carolina they are paramount in importance and almost prohibitive of spring oat growing, though winter oats are quite extensively grown. Proceeding northward, these rusts continue to be of great importance

Even as far north as Wisconsin, regions are known where oat growing has been discontinued on account of rust, and epidemics have been known to extend to the Canadian line and even beyond.

There is great variation in time of ripening of different varieties, two to four weeks in some latitudes, and if, as is usually the case, the epidemic appears suddenly, a difference of one week may decide whether a variety is destroyed or reaches normal maturity.

Both the crown rust and stem rust of oats were cultured for fifty-two successive generations in the uredo stage without any apparent diminution of vitality This number of artificial inoculations will easily represent a period of seven or eight years of successive infection in the field, as eight to twelve days or more are there necessary for each infection to appear, and it is not likely that more than five or six successive infections follow each other during one crop season.

Rust uredospores germinate either not at all or not nearly so well at 90° to 100° F. as at 55° or 75° F. The crown rust of oats, however, is noticeably resistant to heat, while the stem rust of oats is quickly injured.

These two facts, namely, that the uredospores of the crown rust are noticeably resistant to heat, while the stem rust is easily injured by it, are believed to have an important bearing on the distribution of the two forms over the country, and go to strengthen the view that the crown rust is much more widespread and injurious in the more southern localities, while the stem rust usually reaches its highest development in the form of devastating epidemics in the Northern states. This view is in strictest agreement with that of Eriksson, stated in his paper already quoted.

Carleton did not demonstrate the wintering of the uredo of the crown rust or of the stem rust of oats, although it is his opinion that the crown rust passes the winter in the uredo stage in the warm latitudes of the United States.

The great problem of rusts in many places of the South, however, is not

how to live over the winter, but how to pass through the extremely hot months of July, August and September, especially where volunteer grain or wild grasses are scarce at this season.

NOTE.—Careful studies of the wintering of the crown rust and stem rust of oats have not been made, and a discussion of them is omitted.

Undoubtedly the first appearance of these rusts in the spring will also be found to result from wintering of the uredos and windborne spores (as well as from æcidial infection).

Hewitt and Stone (27), 1915, make the following statements regarding crown rust of oats in Ontario:

This rust is mainly confined to the leaves, though it may occur to some extent on the leaf bases and stems. The leaves and leaf bases may become thickly covered early in the season with small oval or elongated, light red or orange-colored spots (uredo sori) Later these same spots in turn are replaced by grayish-black spots of teleuto spores, remaining covered by the epidermis, and frequently arranged in circles around the old spots of the red rust.

This leaf rust of oats forms an exception to the general rule that leaf rusts do not do a great deal of damage, for the attacks of this rust sometimes damage the oat crop very considerably.

Life history similar to that of stem rust, except that æcidial stage occurs on buckthorn, not on barberry shrubs. *Rhamnus cathartica* is a native of Europe and is much used for hedges, and is also now escaped from cultivation It is believed that it would pay farmers to destroy all of these shrubs growing in or near oat fields, and thus do away with at least one of the means by which oat rust is so abundantly multiplied

Fraser (20) in 1915 published the following note on the occurrence of crown rust of oats at Macdonald College, Quebec:

Æcidial stage on species of buckthorn (*Rhamnus*) Uredospores and teleutospores are produced abundantly on the leaves of oats The teleutospore masses do not break through the epidermis, as in the stem rust The teleutospores are easily recognized by their projection at the apex, hence the rust is sometimes called crown rust of oats

Both stages of this rust are rather common in late-sown oats on the college farm, but the early oats are not attacked. The æcidial stage is usually present in the buckthorn shrubs on the college campus.

From the above statements it is evident that the crown rust is of worldwide distribution, that it is highly specialized, and that its life history is not completely worked out in the United States.

The life history of the crown rust may be briefly characterized as follows:

SPORE FORMS.

0. Spermogonia first appear in April, May or June, on the upper surface of leaves of buckthorn.

I. In a few days æcidia break through the lower surface and the yellow æcidiospores are soon shed.

II. If these æcidiospores fall on leaves or other parts of an oat plant they cause there an infection which in eight to fourteen days gives rise to the uredospore pustules. These occur mainly on the leaf blades, although in severe cases of infection the sheaths may become infected, and even the peduncles and spikelets. The uredospore generation may be, and often is, repeated during the season, and thus spreads the fungus to other fields. The uredospore sori are of a bright salmon-orange color, medium in size, rounded oblong (not linear), and sometimes become confluent. The uredospores are nearly round, warty, have several germ spores, and are bright in color when fresh.

III. The teleutospores are formed in the same or similar pustules as the uredospores, but these remain, at least for some time, covered by the epidermis, thus appearing grayish, not so black as in those of the stem rust, which soon rupture the epidermis.

The teleutospores are brownish-black, thick-walled, and the upper cell is provided with a crownlike apex of finger-form processes; hence its name, crown rust. The teleutospores will only germinate after a winter's rest, and then the sporidia so formed will cause infection only on leaves of buckthorn.

BLACK STEM RUST.

Puccinia graminis Pers. f. sp. *avenæ* Erikss. and Henn.

The familiar stem rusts of grain have been known, feared by farmers and investigated by botanists perhaps as long and as much as have any other plant parasites. Eriksson and Henning (13) give the following notes as to the history of the stem rust, and list the various names by which it has been known, in part as follows:

The first mention of the æcidial form in literature was by Jacquin, in 1786, as *Lycoperdon poculiformis* Gmelin, 1791, described it as *Æcidium berberidis*. Lasch described the form on fruits of the barberry as a distinct variety, *fructicolum* (*fructigenum*).

1875. The form on *Mahonia* was described in England by Berkeley and Broome, and in Germany by Magnus

1883. Plowright's work on the teleuto form

1884 DeBary's work on the teleuto form (He had earlier proven the heterœcism of the fungus)

The uredo and teleuto stages were first described by Felice Fontana, 1767 They were only known by the scientific name ten years later

1801. Persoon used the name *Puccinia graminis* as *Uredo linearis frumenti*, and Lambert, *Uredo frumenti*. The fungus has since been known under a number of names

1803	Schumacher II	*Uredo ferruginea*
	III	*Uredo culmorum*
1810	Strauss	*Uredo linearis.*
1817	De Martius	*Uredo frumenti* (*linearis*)
		Puccinia cerealis.
1824	[illegible]	[illegible]
		Puccinia graminis
1833	Wallroth	*Erysibe linearis*
		Puccinia graminis
		Puccinia culmorum
		Puccinia vaginarum.

1888. von Wettstein Verarbeitem zu einer Pilz flora der Steiermark. In Verh. d. K. K. Zoöl. Bot. Gesellsch in Wien. Bd. 38. 1888 Wien. On grounds of priority calls it *Puccinia poculiformis.**

Plowright (38) gave an accurate description of the stem rust, listing *Berberis vulgaris* and *Mahonia ilicifolia* as æcidial hosts, and *Avena sativa* and other cereals and grasses as hosts for the uredospore and teleutospore stages.

Grove (22) gives a historical account of the fungus (with synonomy) and detailed descriptions of the various spore forms. He further states:

This rust is much less common in England now than some of the other cereal rusts. This is, perhaps, due to the extirpation of wild barberries; the æcidium is really uncommon even on cultivated species of Berberis and Mahonia.

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* Arthur still uses this name. The authority for such usage goes clear back to the first description (1786) where *poculiformis* was used as the species name. This is not, however, in accord with the International Code, which provides that nomenclature in the rusts, using the teleutospore form, shall date from Persoon, 1801.

McAlpine (31) describes only the spore forms occurring on grasses and cereals, and states that he has never seen the æcidial stage in Australia, nor has he ever been able to produce it from artificial inoculation, though the stem-rust fungus of cereals there seems to resemble in every other way the form in other countries.

Sydow (47) gives the complete list of synonyms used, describes the spore forms, and makes rather brief reference to the history of the development of opinion and knowledge regarding the connection of grain rust and the barberry.

Eriksson and Henning (13) give a very extensive and complete account of the life history of the stem rust, description of the spore forms, and of their work on biologic forms. They list as æcidial hosts, according to their own observations, *Berberis asiatica, B. buxifolia, B. canadensis, B. vulgaris* and *Mahonia aquifolium*. In addition, the following are listed on the authority of other workers: *Berberis attaica, B. amurensis, B. aristata, B. carolinæ, B. ilicifolia, B. nepalensis, B. neubertii,* and *Mahonia glauca*.

Fischer (18) describes the fungus in some detail, lists the several æcidial hosts, but states definitely that the fungus will *not* infect *Berberis thunbergii,* or *Berberis chinensis*.

Klebahn (30) gives a very excellent historical account of the gradual accumulation of evidence against the barberry. Abstracts from his account follow:

As early as 1660 there were laws requiring the extermination of barberries (Rouen Parliament.)

In England the harmful influence of barberries was noted early in the eighteenth century. (1758.)

In 1776 Withering wrote: "This shrub should never be permitted to grow in 'corn' lands, for the ears of wheat that grow near it never fill, and its influence in this respect has been known to extend 300 to 400 yards across a field."

In 1715 Massachusetts passed a law for the extermination of barberries.

Other North American observers also noted the injurious effect of barberries.

In Germany, 1803, Treviranus spoke of barberries as causing "Misswachs" in grain.

In 1815 the Bremen senate ordered the extermination of all barberries within 500 feet of grain land.

Many observers (Sowerby, 1790, in England) were aware of the effect.

Experimental proofs were only attempted at the end of the eighteenth century. (See Marshall, 1782, in "The Rural Economy of Norfolk" See copy in Plowright, p. 48, 2d ed. (1795), 359.) Cause of the injury was first attributed to the pollen of the barberry; later observers considered there *was* really a connection between "*Æcidium berberidis*" and "*Uredo linearis*" of the grain.

Willdenow concluded the surface of the plant determines whether a fungus will be an æcidium or uredo.

In 1804 there was a severe epidemic and an inquiry as to effect of barberry.

See Banks, 1806, who gave good account and illustrations of the "blight" of "corn" and supposed (but without experimental proof) that the barberry æcidium "seeds" passed into the wheat.

In 1813 Thos. A. Knight believed the barberry communicated the disease to wheat.

In 1805 Sprengel pointed to the possible relation of *Æcidium berberidis* and *Puccinia graminis*.

Injurious working of the barberry was also early recognised in Sweden, 1806; Denmark, 1797.

In 1807 Scholer (a little later) planted out 8,000 barberries, and in 1810-1811 he ran experiments which led him to believe in the intimate connection of the barberry and rust of rye. In 1812 he definitely concluded that, with aid of the wind, rust of barberry goes to rye and again to the *Berberis*.

Hornemann of Copenhagen disagreed with Scholer.

In 1864 studies of other workers, De Bary, Tulasne *et al.*, cleared up the matter by actual scientific experiment and observation of spore formation and infection, teleutospores from *Agropyron repens* to *Berberis*, and æcidiospores from *Berberis* to *Secale cereale.*

In spite of this work, Orsted cast doubt, 1880, on the connection (identity) of the two fungi.

W. G. Smith observed æcidia in seeds of barberry, teleutospores in oat seeds, and held that the disease could arise directly from this source of infection. Even Plowright somewhat distrusted the doctrine of heterœcism

In 1884 Plowright experimented with material from the United States (*Agropyron repens*) and produced æcidial infection.

In 1889 Bolley passed wheat rust to barberry.

In 1899 Carleton passed barberry rust to barley and other hosts

Lists of "united" hosts have been increased by various workers Plowright, DeBary, Eriksson, Barclay *et al.*

Æcidial hosts now recognized are. *Berberis vulgaris, B. lycium, B. canadensis, B. nepalensis, B. aristata, B. amurensis, B. atro-purpurea, B. ilicifolia, Mahonia glauca, M. aristata, M. altaica = silurica,* and *M. aquifolium*

Even though the connection of rusts of cereals with the barberry is now proven, it is still a question of importance, for the number of barberries occurring seems to be not very large; by many farmers the shrub is entirely unknown.

Saccardo (42) lists the æcidial hosts of stem rust and the complete list of grasses on which the form has been collected. A list of synonomy and the usual descriptions (in Latin) of the spore forms are also included.

Henning (24) has published a brief note on the occurrence of the stem rust of oats at Ultuna, Sweden.

In the United States the stem rust of oats has long been reported from almost all oat-growing sections, and probably is the rust most often referred to in accounts mentioning severe damage from "oat rust," but not naming the species of rust present.

The manuals of botany and floras consulted give the following species of *Berberis* as occurring (wild) in the United States:

Berberis nervosa Pursh. 1814.
Range: British Columbia, Washington, Oregon, Idaho. Indigenous

Berberis aquifolium Pursh. 1814. (Also called *Mahonia.*)
Range: British Columbia, Washington, Oregon. Indigenous.

Berberis repens Lindl. 1828.
Range British Columbia to California, Wyoming and New Mexico. Indigenous.

Berberis fremontii Torr. 1859
Range: Infrequent, canyons of Southwestern Colorado to Mexico. Indigenous.

Berberis fendleri Gray. 1848.
Range. Southern Colorado and southward. Indigenous.

Berberis vulgaris L.
Range: European. Naturalized in Eastern and Middle states of United States

Berberis canadensis. Mill.
Range: Woods and mountains of Virginia to Georgia and in Missouri.

Bailey (2) states that in addition to these, several cultivated varieties and horticultural species are present, at least in many parts of the country. It is impossible to say positively whether all of these harbor the stem rust, though it is a well-known fact that *Berberis vulgaris* and its purple-leaved variety, *atropurpurea,* are commonly infected with this rust. As already mentioned, it is pretty certain that *Berberis thunbergii* never is infected.*

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* At Cornell University, during the spring of 1916, heavy infections were produced on young plants of *Berberis vulgaris atropurpurea* growing in the greenhouse, simply by tying around them bundles of straw bearing germinating teleutospores of the stem rust of oats. The spermogonia on the upper leaf surface were distinctly visible in six days; the æcidia on the lower leaf surface appeared a few days later.

Plants of *Berberis thunbergii* treated in exactly the same manner showed no signs of infection. This experiment would seem to establish the fact of the immunity of the Japanese Barberry.

Thaxter (49) reported in 1889 that stem rust had been injurious to oats in Connecticut.

Hitchcock and Carleton (26) in 1894 reported on their experiments on the wintering of grain rusts in Kansas, and state that:

It seems probable that the stem rust does not pass the winter in this vicinity in the uredo stage nor in the mycelial condition. Whether or not it survives the winter further south is a question yet to be answered.

Concerning the occurrence of the stem rust in 1893 they wrote as follows:

Puccinia graminis appeared during the season (June) on the experimental oats of the farm department, and finally became so abundant that by harvest time the crop was very materially injured. Indeed, this season the oat crop in large portions of the state was much injured by this rust. In Wabaunsee county some fields were almost wholly destroyed and the straw so badly lodged that it could scarcely be harvested.

In 1898 Arthur and Holway (1) published a description of the stem rust, and with it their explanation for dropping the long-used and very familiar name *Puccinia graminis*. The defense of their position, as stated by them, is here given:

Experience does not seem to bear out the inference that the teleuto stage alone possesses such marked superiority for specific identification. It is unfortunately true that much doubt often attaches to the application of early names, but an arbitrary contraction of the domain to be covered by the law of priority does not seem to the writers to be the right way to meet the difficulty.

It is not sufficient to give as a host for a rust "various grasses," but is even necessary to name specifically the plant and the part affected. Value in classification of both the uredo and æcidial stage is now recognized, and the old exalted view of the all-importance of the teleuto stage can no longer be firmly held.

Magnus (Bot. Centr. 37, 289) holds it as incorrect to form such names as *Puccinia poculiformis* Jacq. Wettst. for *Puccinia graminis* Pers. Doctor Wettstein, when he made the change (Pilz flora der Steiermark, p. 18), said, "Although it is hard to drop a name as old as *Puccinia graminis*, I feel compelled to do it. There is no doubt that Jacquin described the æcidium of this species in 1786. The species name, 'poculiforme,' under which Jacquin described this æcidium as a *Lycoperdon*, is consequently the oldest name, certainly older than Persoon's of 1797 (in Tent. Dispos. Meth. Fung., p. 39)."

Arthur and Holway describe the stem rust under the name *Puccinia poculiformis* (Jacq.) Wettst., as follows:

HOSTS:

Æcidial, *Berberis vulgaris.*

Uredo / Teleuto stages occur on *Avena sativa* (cultivated oats), *Avena fatua* (wild oats),

and on the other cereals, as well as many grasses.

I.—Æcidia: On more or less thickened and discolored spots, usually in small groups, but when upon growing lateral shoots often covering large areas; margin prominent, white, erect, more or less jagged; æcidiospores, orange-yellow, becoming pale yellow after long drying, isodiametric, polygonal, 14-24*u* in diameter; wall rather thin, smooth, or sometimes rugulose, especially on one side.

II.—Uredospore. Sori large, oblong to linear, on both leaf surfaces, either scattered or confluent into rather large, definite groups, more usually found on the leaf sheaths; soon naked, ruptured epidermis prominent, ferruginous; uredospores elliptic, oblong or obovate, often somewhat constricted in the middle, 19-38 x 14-22*u*, brownish-yellow when fresh, becoming yellow on drying, echinulate; pores usually four, equatorial.

III. Teleutospore: Sori sparingly on leaf blades, more commonly on sheaths, culms and inflorescence, linear, often confluent, black, early naked, ruptured epidermis noticeable; teleutospores oblong fusiform, oblong cuneiform or narrow obovate, 75-60 x 12-22*u*, golden brown, smooth, somewhat constricted in the middle; apex darker colored, considerably thickened, obtuse or rounded; base narrowed; pedicel usually barely as long as the spore, colored like the spore.

Among the most common of rusts. Much less common on leaf *blades* than other species, but frequently seen on culms and sheaths, forming conspicuous black, effused patches. The form of the uredospores, number and arrangement of pores are characteristic, as is the brownish color, quite unlike the clear orange-yellow of those of the leaf and crown rusts.

Carleton (5) reports as follows on his observations and culture work with the stem rust of oats:

PHYSIOLOGICAL RELATIONS. The uredo sori of the stem rust on oats are longer, larger and seemingly a little darker (than those of the stem rust of wheat), and usually there is proportionally more of the uredo present (on oats).

INOCULATION EXPERIMENTS. Successful infection was secured on—

Oats:	Grasses:
Siberian.	*Hordeum murinum.*
Black Tartarian	*Dactylis glomerata*
Amurskii	*Koeleria cristata.*
Dun.	*Arrhenatherum elatius.*
Nackter Kleiner Fahnen	*Trisetum subspicatum.*
Avena fatua.	*Alopecurus alpestris*
Tardeva denese	*Holcus mollis.*
Avena pratensis	*Agrostis scabra*
Fenton's rustproof	*Polypogan monspeliensis.*
Ligowa.	*Festuca sp*
Avena sterilis	*Eatonia sp*
Avena hookeri	*Ammophila arenaria*
	Phleum asperum
	Bromus ciliatus

The following hosts are listed as authentic:	Probable hosts
Avena sativa patula	*Avena fatua*
Avena sativa orientalis	*Avena hookeri*
Avena sativa nuda	*Avena pratensis*
Dactylis glomerata.	*Avena sterilis*
Arrhenatherum elatius.	*Kolleria cristata*
	Lolium perenne.

OCCURRENCE AND DISTRIBUTION The black stem rust of oats is certainly more common than the black stem rust of wheat. However, it is not known whether the stem rust of oats is generally commoner than the crown rust, although definite statements on this point might be made in the case of certain localities, locality apparently being an important feature in this connection

As in the case of stem rust of wheat, the form on oats is not constant in appearance, although perhaps more so than the former. Reports indicate that it is not so common in the Southern states as in the Northern, the crown rust being in the Southern states the more common Stem rust was not seen in Maryland during two years' work there. Straw examined in Texas revealed *only* the presence of the *crown rust* teleutospores.

So far as known, the stem rust of oats does not winter its uredo in the United States

DAMAGE. The damage which this rust causes to oats in the United States is even greater than that produced by the form on wheat. Almost every year thousands of acres are totally destroyed in some portion of the country by this rust, the damage being greatest north of 37° North latitude and east of 95° west longitude. Eriksson reports it as very destructive in Sweden.

Clinton (9) reports on the stem rust of oats as follows:

This rust produces elongated outbreaks on the stems and leaf sheaths These are at first the reddish uredo stage but later the black teleuto stage. The stems are weakened by the attacks of the fungus, and badly rusted grain is apt to lodge. The barberry is the host for the æcidial stage, but apparently the fungus often skips this step in its life cycle.

This rust very commonly occurs *with* crown rust and the injury they cause to the crop of oats is sometimes considerable. Very little can be done to lessen these troubles.

Smith (44) writes as follows regarding the stem rust of oats as found in California:

Produces numerous pustules of the black or red rust on the surface of the plants, sometimes covering the leaves with the reddish, powdery spores. Sometimes abundant in wet seasons, badly injuring the crop.

No treatment is feasible save the use of resistant varieties.

Davis (11) reports *Puccinia graminis* Pers. (both uredospore and teleutospore stages) on oats in Wisconsin, 1914.

Howitt and Stone (27) report the stem rust present in Ontario, and describe its appearance and the injury caused. They write as follows concerning the barberry stage of the rust:

The barberry is not necessary for the continuance of stem rust, for it may have several other ways of passing the winter:

1. Wintering of the uredospore.
2. Wintering of the mycelium in winter grain, or volunteer grain plants, or on wild-grass hosts.
3. Wind distribution of spores from the South
4. Rust *in* the seed.

The barberry *does* increase the severity of stem rust, and may act as a reinvigorator of the fungus.

BARBERRY IN ONTARIO. There are several species, *Berberis vulgaris* is most frequently found. This species and its purple-leaved variety both harbor the stem rust, and it is now contrary to law to plant them in Ontario. (Copy of the "barberry act" appended to their publication.)

The Japanese barberry (*Berberis thunbergii*) may be planted, as this species does not harbor the rust.

Conditions favoring rust are said to be:

1. Cool, damp weather at heading time.
2. Poorly drained land.
3. Fields so situated that air drainage is poor

Suggested means of (partial) control are

1. Destroy all *Berberis vulgaris*.
2. Well-drained fields.
3. Early maturity secured by early seeding in a well-prepared seed bed.
4. Choice of high-yielding varieties and of those not badly injured by rust
5. Use pure seed of only one variety, to insure even ripening
6. Treat all seed for smut, as plants infected with smut are very subject to rust
7. Sow only sound, plump grain
8. Use barnyard manure or other nitrogenous fertilizers *with care*, as they may produce a rank growth, which invites rust.
9. Field management: Crop rotation, proper manuring, thorough tillage, eradication of weeds and wild grasses, etc.

Taylor (48) writes as follows on the rust of oats in New Hampshire:

The fungus attacks leaves and stems at time of heading, or sometimes several weeks earlier. The disease weakens the vitality of the plant to such an extent that it fails to produce seed and frequently breaks down and dies.

In some sections of the state the rust is unquestionably the worst pest of oats. Although its depredations are somewhat periodic, being more disastrous some years than others, the most destructive attacks come in seasons of unusual moisture and warmth during the month of June, which induces the oats to make a large, quick growth. Whether the quick, succulent growth renders the plant more susceptible to the attacks of the fungus, or whether the stated weather conditions are more congenial for the growth of the fungus, the writer is unable to say. Perhaps both premises maintain.

The time of seeding also seems to have an appreciable effect upon the extent of rust. The writer has frequently observed that early-sown fields of oats have suffered less from rust than late-sown ones.

In 1906, in order to get some data on this question, a series of small plats were seeded to Welcome oats at intervals of one week, April 20 to June 8.

Results are shown in the following table:

Date of seeding.	*Date of ripening.*	*Amount of rust.*
April 20	Aug. 3	None.
April 27	Aug. 8	None.
May 4	Aug. 13	Slight.
May 11	Aug. 14	Slight.
May 18	Aug. 19	Considerable.
May 25	Aug. 22	Much.
June 1	Aug. 26	Much.
June 8	Sept. 6	Very bad.

Zavitz (52) published the following data on thickness of seeding as a factor influencing rust in oats. The kind of rust is not mentioned.

THICKNESS OF SEEDING OATS, ONTARIO AGRICULTURAL COLLEGE.

AVERAGE RESULTS FOR FOUR YEARS.

Inches between plants.	Seed per acre.		Heads per plant.	Per cent of heads per acre.	Plant height, inches.	Per cent lodged.	Per cent rust.	Days to mature.	Pounds per bushel.	Yield per acre.	
	Pounds.	Bushels.								Straw, tons.	Grain, bushels.
1	414 4	12 34	1 0	100	20 4	5 6	11 8	91	25 0	1 75	30.60
2	104 0	3 06	1 1	31	27 8	11 9	15 0	93	31.4	1 58	34 95
3	46 1	1 36	1 3	17	32 6	12 8	17 8	94	33 2	1 52	41.73
4	26 0	76	2 0	13	33 1	29 9	20 9	95	31.5	1.29	38 99
6	11.6	34	4 2	12	35 3	35 8	25 4	97	28 6	1 40	37.42
8	6 5	19	6 5	11	34 9	34 7	27 7	99	26 4	1 20	31 77
12	2 9	09	11 2	9	34 9	30 1	33 2	100	23 9	1 03	21.93

The average results of the per cent of rust are very interesting, as they show a gradual increase in amount of rust on the straw of the oats from the thickest to the thinnest seedings. The plants from the thin seeding had about three times as much rust as those from the thick seeding. The amount of rust on the plants which were four inches apart was about the average of that of the thinnest and the thickest seedings.

Newton (39) as early as 1871 had recorded results which led him to draw similar conclusions to those of Zavitz, *e. g.*, that plants closely spaced (from heavy seeding) were less rusted than those having more space (from light seeding). Newton gives the following account of his observations:

I have observed that oats standing very thinly on the ground are several days later in ripening, and are much more liable to be injured by rust than those that are thickly sown. I have raised them in drills and have seen them raised in this way, and in nearly every case they were more or less affected by the rust and were from one to two weeks later than those sown in the usual manner, and in some cases were so badly rusted as not to ripen at all.

On one strip about two feet in width at the side of the field only a small quantity of seed was scattered, probably not one-fourth as much as on the land adjoining. At the time of cutting them, the oats that were thickly sown were ripe, the straw bright and clean, showing no signs of rust, while those on this small piece were perfectly green and very badly rusted Most of the field was sown at the rate of three and one-half bushels per acre.

To test the question of thick and thin seeding, a small part of the field was sown at the rate of two bushels per acre. On this piece the oats were two or three days later than on the rest of the field and showed signs of rust, but were not materially injured by it. The result of my observations is that oats that are thickly sown are much less liable to be injured by rust, that they ripen earlier, and that the straw is brighter and of better quality than when only a small quantity of seed is used. This liability to rust is one great objection to very thin seeding

Fraser (19) reports stem rust is usually common on oats grown at the farm of Quebec Agricultural College.

Freeman and Johnson (20) write as follows concerning the distribution of oat stem rust

In the southern states of the eastern half of the United States—that is, south of and including Tennessee and North Carolina—rust of certain cereals has been so serious as almost to prohibit the growing of them in those regions. It is very difficult, for instance, to grow spring oats profitably in portions of the southernmost tier of states east of the Mississippi river, one of the chief difficulties being rust Winter oats are the only cereal grown extensively in this area

Regarding damage, these authors are of the opinion that.

The stem rust of oats, if not more harmful, is fully as destructive as the similar form on wheat, and its distribution is somewhat similar.

Much of the real damage caused by stem rust results from the severe infections of it which sometimes occur on the spikelets and spikelet stems

Concerning the specialization of this rust they write as follows:

The oat rust is the most closely specialized of the biologic forms of *P. graminis* on the small grains, but in its ability to infect the other species under rarely occurring conditions still shows its close affinity to the other rusts

Of all the stem rusts on the small grains, that of oats is the most distinctive and individualistic in appearance, having larger pustules of uredospores, which are formed very commonly both on stems and leaves (as in barley), in sharp contrast with the more restricted location of the pustules in the stem rusts of wheat and rye.

As a biologic form, the stem rust of oats may be said to be generally confined to oats. It can at times be carried to barley, but never produces large or vigorous pustules It is only rarely that transfers to wheat and rye can be made.

Stakman (45) reports as follows on his experiments with *Puccinia graminis avenæ:*

GENERAL STATEMENT.

This rust in this country is supposed to infect no cereal except oats, although it is capable of infecting a number of grasses. Carleton was unable to transfer it to wheat, barley or rye. Eriksson mentions it as being found on oats and eighteen species of grass in Sweden. Freeman and Johnson, however, find that it can be transferred to barley also, and they report that Derr succeeded in obtaining direct transfers from oats to wheat and rye.

CONCLUSIONS FROM INOCULATION RESULTS ON RYE.

The stem rust of oats can be transferred directly to rye. This was accomplished most easily when the plants were grown in heavily manured soil. Exposing them to various anæsthetics before inoculation seems to increase the virulence of infection slightly, while leaf injury had no apparent effect. In the various trials under different conditions, 27 out of 236 leaves developed pustles and 73 were flecked. Under conditions which might exist in the field, 12 out of 73 leaves produced pustules and 22 were flecked.

INOCULATIONS ON WHEAT.

The stem rust of oats can be transferred to wheat only with great difficulty. Carleton did not succeed in obtaining infection in his experiments, Freeman and Johnson made 100 inoculations, but none was successful. They report, however, that Derr was able to make transfers.

SUMMARY OF INOCULATION ON WHEAT. Out of a total number of 283 leaves inoculated under varying conditions, only 4 developed pustules and 113 became flecked, showing that although the rust of oats can sometimes develop on wheat, it can seldom attain to pustule formation. The severity of infection, always slight, can be increased somewhat by exposing plants to be inoculated to anæsthetics. The experiment with high fertilization of soil seems to indicate that here, as well as in the case of rye inoculated with oat rust, the mycelium is enabled to develop more extensively and possibly produce more spores than when ordinary soil is used.

Fife wheat (Minn. No 163) was inoculated with stem rust of oats, and it was found that only a few host cells were involved. The contest between host and parasite is short and decisive, the hyphæ seldom developing sufficiently to give any external evidence that the germ tube has even entered. This extreme case of immunity seems to differ in degree only from those conditions presented by resistant varieties

INOCULATIONS ON BARLEY.

The results of this series of inoculations were very similar to those obtained by other investigators. The behavior of the rust was typical of its usual behavior on an uncongenial host plant. The flecks were small in nearly all cases, and were especially sharp when plants had been exposed to anæsthetics. Only one leaf out of 147 inoculated under varying conditions was pustuled. Flecks were formed on 32.

GENERAL SUMMARY.

The stem rust of oats can be transferred successfully from oats to any one of the other cereals. It infects rye much more easily than wheat or barley Anæsthetics help to break down the barriers, as does a high degree of soil fertilization. It should be mentioned that this fact seems due, not to any new ability the rust fungus has of attacking an uncongenial host, but to an increased capacity for development. Here again evidence of the possible nature of resistance is offered by the inoculated plants. The flecks, whether large or small, consist in many cases of dead tissue of the host plant. Histological examination shows that the fungus gains entrance but cannot develop to any extent in these areas which are killed by the fungus itself.

Stakman and Piemeisel (46), from their studies of the biologic forms in the stem rusts, give the following list of hosts for the stem rusts of oats:

P. Graminis avenæ Erikss. and Henn.

Oats (*Avena sativa*).
Avena fatua.
Avena elatior.
Anthoxanthum odoratum.
Holcus lanatus.
Phalaris canariensis.
Koeleria cristata.
Dactylis glomerata.
Bromus tectorum.

They found also that this form has quite consistently weakly infected the following:

> Barley.
> *Elymus canadensis.*
> *Lolium italicum.*
> *Lolium perenne*
> *Festuca elatior.*

The salient points of the life history of stem rust are here summarized:

SPORE FORMS.

0. Spermogonia first appear in spring on the upper surface of barberry leaves.

I. Within a short time the æcidial or cluster cups are evident on the lower surface, and their yellow spores soon are liberated, and if blown to an oat leaf or stem, there cause infection.

II. In eight to twelve days (or more in cool weather) the fungus growth (mycelium) so formed within the oat plant will give rise to a number of uredospore sori. These may first be seen as light, yellowish-green flecks, but soon the epidermis is ruptured and the dark-reddish uredospores are dispersed. The uredo-sori are large, longer than broad, and often confluent, forming great linear patches of rusted tissue. The epidermis is torn open early, and the sori are typically erumpent, and are not scattered as in the case of the crown rust.

The uredospores are not typically nearly circular in outline as in the crown rust, but are ellipsoidal. They are of a dark reddish-brown color, not bright yellow as in the crown rust, and have (usually) four equatorial germ pores.

III. Towards harvest time the black-rust stage gradually replaces the uredo, and the teleutospores are formed in the same or similar sori. They too rupture the epidermis early and form linear dark-brown to black, erumpent pustules.

The teleutospores are clavate, thick-walled (especially thickened at the apex), and the tip of the apical cell is rounded, blunt, or unevenly tipped, but not provided with the finger-form projections which form the "crown," so characteristic of those of the crown rust.

The teleutospores will only germinate after a winter's rest, when the typical four-celled promycelium is formed, and from each of these cells a branch is sent out, bearing a sporidium. These in turn, if blown to a barberry leaf, will enter and cause infection, thus completing the life cycle.

Notes on the Distribution of Oat Rusts in the United States.

The following brief observations are from Carleton (5):

California. Reports indicate that rust does not commonly injure the grain, still in some places *oats* are severely damaged. Losses are confined almost wholly to the coast districts.

It is claimed black oats are more resistant than white.

Georgia. In this state, as in all the Gulf states, oats are seldom injured by rust. Texas Rustproof is the variety commonly grown.

Illinois. Oats are commonly and often seriously damaged by rust.

INDIANA. Oats are commonly damaged by rust. Late varieties are invariably much more liable to rust than the early ones. In some instances the growing of oats has been abandoned on account of rust. Grain is said to be free from rust in the warm, sandy soils. Some claim rust is very severe only once in two to five years. Black stem rust is the most injurious species.

IOWA. Rust often destroys the oat crop. It is always the black stem rust that is particularly injurious.

KANSAS. Oats are often greatly damaged by stem rust in the eastern portion, and are sometimes a total loss. The crop suffered greatly in 1893. Occasionally fields of late-sown oats are entirely destroyed before harvest.

KENTUCKY. Oats are extensively injured.

MARYLAND. During 1895 and 1896 there was seen an abundance of crown rust of oats, but it did not appear to cause any particular damage. Black stem rust was not observed. Much oat rust has been reported from Cecil county.

MICHIGAN. Oats suffer more than wheat from rust. Rust rarely occurs in the sandy districts.

MINNESOTA. In certain years oats are greatly injured. White Russian oats are said by some to be rust resistant.

MISSOURI. There is considerable rust here, but not much is known concerning the relative proportions of the leaf and stem rusts Oats are often much injured.

NEBRASKA. In the eastern portion of the state oats are often severely damaged.

NEW YORK. Oats are often injured, especially in Erie and Wyoming counties.

NORTH DAKOTA. Oats are often injured. White Russian oats are thought to be somewhat rust resistant.

OHIO. Black stem rust is occasionally very prevalent, and there is much more injury to oats than to wheat.

OREGON. Cereal rusts cause only slight damage as a rule. Occasionally oats are considerably affected by the crown rust, as in Sherman county in 1892.

PENNSYLVANIA. Oats are very commonly injured. (Much of the damage may, however, be due to the red leaf-blight disease.) Fertilizers are supposed to materially aid the grain to escape rust, by causing rapid growth and early maturity. Rust is always worse in the lowlands.

SOUTH DAKOTA. Oats, especially when planted late, are often badly rusted.

TENNESSEE. Little injury is done to oats.

TEXAS. Oats are seldom injured to any extent.

VIRGINIA. Oats (in the Shenandoah valley) are damaged quite often. The rust is most abundant in the lowlands.

WISCONSIN. *It is claimed by some that White Russian oats possess a considerable degree of resistance.* Black stem rust constitutes a good proportion.

The following notes on the distribution of oat rusts are from the records of the Plant Disease Survey of the United States Department of Agriculture.

They are in most cases from the annual reports sent in by the plant pathologists of the state experiment stations:

ALABAMA. Prof. F. A. Wolf reported the crown rust in 1912.

In 1915 both crown and stem rust were reported as common in the state, causing a loss estimated at 5 per cent.

ARKANSAS. In 1907 the crown rust was reported by Prof. W. M. Scott.

CALIFORNIA. E. C. Johnson reported the crown rust in 1911.

DELAWARE. Prof. M. T. Cook reported stem rust of oats as worse in 1910 than in 1909. In 1907 crown rust reported as occasional. In 1908 crown rust possibly less severe than in 1907. In 1909 crown rust about as in 1908. In 1910 crown rust worse than in 1909. In 1911 crown rust less than in 1909. In 1912 crown rust reported. In 1913 crown rust reported. In 1915 crown rust common; injury 5 per cent.

GEORGIA. Crown rust reported by E. C. Johnson in 1911.

In 1913 Prof. A. C. Lewis reported more than the normal amount of oat rust (more than in 1912). Present in 50 per cent of the fields; estimated loss, $5,000. Very injurious in some fields.

The oat crop was much more affected with rust this season than usual. The fields, though, that had the best preparation and were well fertilized suffered least from rust. We could not see any marked difference between the different varieties of oats, such as Bancroft and Texas Rustproof.

IDAHO. Prof. C. E. Temple reported in 1913 that stem rust was very prevalent; 2 to 5 per cent of the crop injured in north Idaho.

ILLINOIS. In 1911 Prof. J. T. Barrett reported that very little stem rust was noted.

In 1911 Professor Barrett reported the crown rust was more than usually prevalent.

In 1912 as severe on late oats, little on early.

INDIANA. In 1904 Dr. J. C. Arthur reported rust on oats to have done little or no damage; the oat crop was very heavy.

In 1905 Dr. J. C. Arthur estimated a loss of 3 per cent from stem rust. The reports were all from the southern counties. Observations in the northern part of the state indicate that the oat crop was unusually free from rust this year.

In 1906 Doctor Arthur reported 3 per cent of crop injured, less than in 1905, and weather not favorable.

In 1907 Prof. F. D. Kern wrote as follows: "It is impossible to say which rust is meant in the reports on oats, and further the unfavorable weather caused a disease or physiological disturbance which many mistook for rust."

Oat rust was reported by Prof. F. D. Kern in 1910 and 1912.

In 1908 Prof. F. D. Kern reported an estimated loss from crown rust of 20 per cent. In 1909 crown rust reported. In 1911 crown rust reported as normal amount. In 1913 crown rust reported. In 1914 crown rust reported from several counties. In 1915 crown rust reported from all over state.

IOWA. Dr. L. H. Pammel reported stem rust as bad in many counties in 1904.

In 1905 Dr. L. H. Pammel reported oat rust as not so prevalent as in 1904, loss being less than 3 per cent. Earliest report, June 15. Weather conditions

not favorable—cold nights and cool rains. Reported as severe in ten counties; reported as some damage in thirty-two counties; reported as no damage in one county.

In 1906 the stem rust was less than in 1905; only 1 per cent of the crop injured. Earliest report June 20. Weather conditions not favorable—cool weather. Rust did little damage in state except in northwestern part, where one man reported a loss of 60 per cent. Late oats are more rusted than early. Both species of rust equally common.

In 1907 Doctor Pammel reported there was more stem rust than in 1906; 50 per cent of crop was injured. Earliest report, June 21. Weather was favorable—rain and warm weather late June and early July. All varieties were badly rusted, the earliest (such as Early Champion) the least. Some of Norton's hybrids and Clydesdale were badly rusted. Some reports read, "oats red with rust." Much of oats averaged only 16 pounds per bushel. All sections of the state report less than one-half crop, and in Story county one-fourth crop.

In 1908 Doctor Pammel reported as follows: "Oats were comparatively free in some places, especially the early varieties, and on high ground. In low places the stem rust was rather bad. The northern sections of the state suffered more than the southern. Yield and weight per bushel were better than in 1907. Stem rust was quite prevalent, injuring 25 per cent. Weather was favorable for rust—too much rain, not enough sun. Stem rust was not as severe as in 1907, and there was a better crop."

In 1909 stem rust was reported as common; 5 per cent injury, less than in 1908; favorable weather.

In 1910 stem rust was not abundant; 2 per cent injury; earliest report, June 25; weather unfavorable.

In 1911 stem rust was not common; 1 per cent injury; weather unfavorable.

In 1912 injury was 2 to 5 per cent; more rust on low than on high ground. Stem rust occurs in every county of the state.

In 1913 stem rust was reported as common, but not serious this year; weather favorable.

In 1914 not so much stem rust as in wet years; earliest reports, June 15.

In 1915 stem rust abundant in some sections.

Doctor Pammel reports on crown rust as follows:

"Occurred in 1904, 1906 and 1907. In 1908 estimated injury was 25 per cent. Weather favorable—too much moisture—but better crop than in 1907. No resistant varieties.

"In 1909 crown rust was common; 5 per cent injury. Less rust than in 1908; larger yield, heavier oats.

"In 1910 crown rust was not abundant; 2 per cent injury. Earliest reports, June 25 to July 8. Weather unfavorable. Little rust on early-maturing varieties, as Early Champion. The best crop of oats for several years.

"In 1912 crown rust reported, but weather unfavorable.

"In 1913 weather was unfavorable. Oat crop excellent in some places; other places light, due to unfavorable weather at seeding time. Crown rust is widely distributed; did some damage; more in northern than in southern Iowa.

"1914, crown rust not so abundant as in wet years. Earliest report, June 15."

KANSAS. Oat rust reported by E. C. Johnson in 1911.

In 1914 L. E. Melchers reported stem rust as quite prevalent at Hays. Earliest reports, June 17.

In 1915 crown rust was reported from Miami and Thomas counties. Earliest report, July 16.

LOUISIANA. In 1907 Prof. H. R. Fulton reported the prevalence of crown rust as about the same as usual.

In 1908 injury from crown rust was very general and the estimated loss considerable. Earliest report on May 9.

E. C. Johnson observed rust on oats in 1911. In 1911 Prof. C. W. Edgerton reported crown rust as very common; estimated loss considerable; first appearance in April.

In 1912, 1913 and 1914 crown rust was again reported as very common; estimated loss considerable. Also 1915; first appearance in April.

MAINE. In 1908 Prof. W. J. Morse reported that "apparently both the stem and crown rust are present." Neither is severe enough to cause alarm to the grower, but rust is common and widely distributed in the state.

In 1912 Prof. C. E. Lewis reported more stem rust than in 1911. Weather favorable—much moisture and many cloudy days. Stem rust causes much damage, especially to late seeded oats.

MARYLAND. Prof. J. B. S. Norton reported on oat rust as follows: In 1903, very destructive; in 1907, abundant; in 1908, less than usual; in 1909, none seen

Never seen on winter oats. Some volunteer oats (in summer) are badly rusted. In 1915 rust was reported.

MASSACHUSETTS. Prof. G. E. Stone reported oat rust as being unusually prevalent in 1906, with rather heavy losses. Weather conditions were favorable; more injury from rust than for many years.

In 1915 stem rust was reported as frequent, and crown rust seen only at Amherst.

MICHIGAN. In 1907 Prof. B. O. Longyear reported crown rust as plentiful on fall oats in an orchard during September and October.

MINNESOTA. In 1907 Dr. E. M. Freeman reported stem rust as quite severe throughout the Mississippi valley, causing considerable damage. The light oat crop was, however, not due entirely to this rust; other diseases (including the crown rust) and the green bug were also important factors. In the northern part of the valley the larger part of the damage was done by the stem and crown rusts.

In 1908 Doctor Freeman reported stem rust as quite serious throughout the state, but occurrence spotted as in wheat. Was very serious in some parts of the state.

In 1909 there was less stem rust than in 1908, as weather conditions were not favorable (dry July). This rust is common every year. Losses this year were local, due to low ground or wet location. Found usually together with the crown rust. Æcidial stage on barberry shrubs probably more abundant than usual.

In 1911 there was much more stem rust than usual; estimated loss, $1,000,000. Earliest report in June.

In 1912 stem rust generally distributed; estimated loss, $500,000. Earliest report, June 6.

In 1913 quite generally distributed, less than usual. Earliest report in June. Estimated loss, $350,000.

In 1905 Prof. C. P. Bull reported "the usual amount" of crown rust, slight injury and loss; earliest report in May; weather conditions were favorable, *i. e.*, a wet season. Crown rust is always present, but appears to do but little damage; heavy yields are secured from badly infected fields.

In 1907 Doctor Freeman reported crown rust as very common; almost always associated with stem rust.

In 1908 Doctor Freeman reported crown rust occurring about as in the case of stem rust, causing considerable damage. As usual, the two rusts work together.

In 1909 the losses from crown rust were local; unfavorable weather for the rust—dry in July. This rust is common every year, and it *with* the stem rust probably causes the greatest loss of any cereal rust.

Oat rusts are especially bad in the northeastern part of the state. Local losses occur even in dry years Resistant varieties are not known, though early varieties more often escape than late varieties. The æcidial stage is exceedingly common on cultivated and wild buckthorns all over the state.

The following notes on the distribution and occurrence of oat rusts in Minnesota were obtained during the summer of 1915 by Mr. J. R. Holbert, then in the employ of the Bureau of Plant Industry, in coöperation with the Minnesota Agricultural Experiment Station. In practically every field the crown rust was present in amounts ranging from a "trace" to 40 per cent or more, but apparently without causing severe damage to the crop

On the other hand, there were only a few fields which had an appreciable amount of stem rust, but in at least one of these the note indicates damage to the crop, which appeared stunted. We must conclude, then, that in this locality and at least during the season of 1915, the crown rust was much more commonly present than the stem rust, and in some fields in amounts almost constituting an epidemic It may even be said that stem rust was here rarely met with.

Report of the cereal-disease trip in Carver, Hennepin, McLeod, and Meeker counties. (July 15, 1915.) There were traces of leaf rust in every field, and occasionally a trace of stem rust.

Report for Goodhue county. There was no stem rust on oats in this county. At places, however, the leaf-rust infection was very high.

Report for Wabasha county—Wabasha. (Observations made July 19) Stem rust was observed in one field of oats The infection was about 10 per cent, and, since the straw was lodged badly and the growth very rank, it is probable that stem rust caused some loss in this field. In this same field there was a 25 per cent infection of crown rust.

In an adjacent field the oats contained only a trace of leaf rust.

Report for Wabasha county—Millville, Plainview. (Observations made July 20 and 21.) Oats: Although there was considerable crown rust, the crop was entirely free from stem rust.

Report of Olmstead county. (Observations made July 22, 1915.) There was a trace of crown rust in every field. The oats in one contained a trace of stem rust

Report for Dodge county. (Observations made July 23, 1915.) There was a trace of stem rust in one field and a rather heavy infection of crown rust in many fields.

Report for Waseca county. (Observations made July 24, 1915.) Only one field of oats contained a trace of stem rust. At no place was there more than a 10 per cent infection of crown rust.

Report for Blue Earth county. (Observations made July 26, 1915.) The oats were free from stem rust with the exception of a trace in one field. Crown rust was generally distributed—about a 25 per cent infection.

Report for Watonwan county. (Observations made July 27 and 28.) There were traces of stem rust in several places. Crown-rust infections were rather high at times—40 to 65 per cent.

Report for Redwood county. (Observations made July 29, 1915.) The crown-rust infection was generally heavy—40 to 60 per cent. Stem rust was observed only in traces.

Report for the vicinity of Tracy, Lyon county. (Observations made July 30, 1915.) Generally the oats were comparatively disease free. There were traces of stem rust and a heavy infection of crown rust.

Report for Lyon county. (Observations made July 31, 1915.) There were traces of stem rust in several fields of oats, and a little less than the usual amount of crown rust.

Vicinity of Ortonville, Big Stone county, Minn. (Observations made August 3, 1915.) Most of the oats contained some stem rust. In one field the infection was 10 per cent. The rust pustules were long. Around each the tissue was turning a reddish-blue color. The uredospores were much browner than those of stem rust usually are. The whole field presented a very stunted appearance.

Report for Stevens county. (Observations made August 4, 1915.) The oats, though comparatively free from rust, were rather poor in quality.

Report for Pope county. (Observations made August 5, 1915.) Little stem rust was found. In two fields the crown rust infection reached 60 per cent.

Report for Grant county. (Observations made August 6, 1915.) Only traces of stem rust were found in the oats. The usual amount of crown rust was present.

Report for Wilkin county. (Observations made August 7, 1915.) Some of the oats were slightly infected with stem rust.

Report for Ottertail county. (Observations made August 9, 1915.) Oats were practically free from stem rust so far as damage was concerned.

Report for Wadena county. (Observations made August 10, 1915.) The oats, though not promising as heavy yields as some of those in Ottertail county, were very clean and of a pure variety (White Russian). There was no stem rust, only traces of crown rust, for the most part.

Report for Becker county. (Observations made August 11, 1915.) Oats were troubled very little with disease.

Report for Clay county. (Observations made August 12, 1915.) The oats were not badly rusted, there being only traces of stem rust and 10 per cent leaf rust.

Report for Norman county. (Observations made August 13, 1915.) With the exception of one field, the oats were practically free from disease. However, this one field contained 3 per cent of stem rust.

Report for Marshall county. (Observations made August 16, 1915.) Very little rust was observed on oats.

Report for Kittson county. (Observations made August 17, 1915.) Conditions in Kittson county were similar to those in Marshall county.

Such detailed figures as these, when obtained by experienced men, are much more useful than the scattered observations usually available. Could such a rust survey be made each season in the important oat-producing states for a ten-year period our true understanding of the problem would be greatly increased.

NEBRASKA. In 1903 Dr. C. E. Bessey reported oat rust as generally rather abundant and causing considerable damage. In some places it was very destructive.

In 1904 Doctor Bessey reported the occurrence of oat rust, in some cases producing a loss estimated as high as 50 per cent. Area affected is practically the same as that for wheat rust.

In 1905 Prof. F. D. Heald received report of the occurrence of oat rust in eight counties.

In 1906 crown rust reported as about the same as in 1905—5 to 50 per cent of the crop injured.

In 1907 crown rust was reported from six counties and stem rust from only one.

In 1909 Prof. E. M. Wilcox reported oat rust at Lincoln.

In 1911 Prof. E. M. Wilcox reported exceptionally severe attacks of the crown rust in western Nebraska, culms badly diseased.

NEW JERSEY. Stem rust reported as common in 1913. Crown rust reported by Prof. M. T. Cook in 1913 and as common in 1914.

In 1915 crown rust reported as common over the entire state. Stem rust in 1915 reported as only occasional.

NEW YORK. In 1903 Professor Whetzel reported both crown and stem rust as very common.

In 1911 E. C. Johnson reported the occurrence of oat rust.

In 1913 Prof. M. F. Barrus reported stem rust as common in five counties.

In 1914, stem rust not as abundant as last year; only slight injury.

In 1915 stem rust was reported as generally prevalent, but not bad. Earliest report, July 25.

NORTH CAROLINA. Prof. F. L. Stevens reported in 1905 that oat rust was about as prevalent in that year as the one previous; estimated loss 10 to 20 per cent.

Prof. H. R. Fulton in 1912 reported crown rust as causing slight financial loss. It developed late.

In 1913 crown rust was more prevalent than usual; caused slight financial loss.

In 1914 crown rust about as prevalent as usual, causing slight financial loss.

NORTH DAKOTA. In 1907 Prof. H. L. Bolley reported as follows: "Oat rust occasioned apparently little loss, but in my opinion the rust reduces the weight of grain more than is supposed, especially in wet regions. Several farmers report the rust more destructive on rich land."

In 1908 Professor Bolley reported relative prevalence of stem rust as low; only 2 to 3 per cent injury. Earliest reports, July 4 to 15. Most damage in late oats.

OHIO. In 1904 oat rust thrived.

In 1905 less than in 1904; 18 per cent of crop injured. Estimated loss, $360,520. Crop of much importance in the state. Earliest report, May. Weather was favorable—prolonged moisture. No rust-proof sorts as yet.

In 1906 oat rust about as prevalent as in 1905. Reported from sixteen counties. Negative reports from five counties. Eleven per cent of crop injured, in most severe case 50 per cent. Estimated loss, $350,000. Earliest report, June 1. Weather conditions favorable.

In 1907 Prof. A. D. Selby had reports of oat rust from two counties. Weather was cold. Injury was overshadowed by that caused by leaf blight.

In 1908 Professor Selby reported crown rust as more prevalent than usual. Reported from three counties; a large (estimated) loss. Earliest report, July 29. Weather was favorable for the rust; plants were checked by other troubles. Planting was done very late.

In 1909 there was less crown rust than in 1908; it was reported from four counties.

In 1910 crown rust was reported from one county. Earliest report in July.

In 1911 crown rust reported from four counties. Stem rust was reported from two counties.

In 1912 crown rust reported from one county. Stem rust was reported from five counties.

OKLAHOMA. In 1915 crown rust (listed as *Puccinia rubigo-vera*) quite common. Earliest report, March 30.

In 1915 stem rust reported as common, 1 to 50 per cent loss. Earliest report in April. Bad in some localities.

PENNSYLVANIA. Prof. H. R. Fulton in 1908 reports 5 per cent of crop injured by oat rust. Earliest reports in May.

In 1908 stem rust is reported to have injured 15 per cent of the crop. Estimated loss, 5 per cent. Early oats escaped injury. Earliest report, June 15.

In 1909 Prof. H. R. Fulton reported crown rust more prevalent than usual. Fifteen per cent of the crop injured. Estimated loss, 5 per cent. Earliest report, June 1.

Crown rust also reported in 1910.

In 1911 crown rust first reported about June 10; less prevalent than usual. Estimated loss, 1 per cent.

Prof. C. R. Orton in 1913 reported crown rust as relatively more prevalent than usual. Twenty-five per cent of the crop was injured. Estimated loss, 5 per cent. Noticed rather early, during the wet weather in July.

SOUTH CAROLINA. Crown rust was reported in 1908.

In 1912 Prof. H W. Barre stated that crown rust was only reported from one county. First appearance in October. In one field visited in November the disease was causing serious loss, which is the first time this has been observed in the fall.

Crown rust also reported in 1913.

SOUTH DAKOTA. In 1910 Prof. E. W. Olive reported the crown rust as common, but not serious. Weather conditions were unfavorable and the æcidial stage on *Rhamnus* was killed by early frosts, there being, consequently, but little *Rhamnus* infection.

In 1914 H. S. Coe reported stem rust of oats as bad; 30 per cent injury. Many fields (in Brookings county) entirely destroyed.

TENNESSEE. Prof. S. H. Essary reports oat rust (*Puccinia rubigo-vera*), probably meaning crown rust, collected at Knoxville in 1910 and also in four other counties in 1911.

Following is the 1915 report of W. T. Evans, collaborator, Cereal Disease Survey, made in coöperation with the Tennessee Agricultural Experiment Station:

Points visited: Dalton, Athens and Clarksville, all in northern Georgia, and representing the northwest, north central and eastern mountainous regions of the state; Cullman, Decatur, Tuscumbia and Huntsville, all in northern Alabama.

In Tennessee the following counties were visited: East: Roane, Knox, Hamilton. Middle: Coffee, White, Putnam, Smith, Warren, Wilson, Davidson. West: Madison, Woakley, Obion.

In Kentucky the counties visited were: Christian, Jefferson, Carrol, Owen, Fayette, Woodford.

The crown rust was the one mainly found on oats. Time of planting seemed to have been important in determining the amount of rust present in the various fields.

Berberis vulgaris (common barberry) was not seen except in a nursery at Louisville, Ky. It is probably grown as an ornamental shrub in the cities, though most hedges are of *Berberis thunbergii*, but does not occur wild in this section.

Rhamnus caroliniana occurs (wild) in Tennessee. Its (possible) relation to the crown rust of oats is not known. Other species of *Rhamnus* probably occur, at least in nurseries and as ornamentals in cities

The infection of stem rust was not of long standing in any field, probably due to the unfavorable season No data were secured as to the date of first appearance of rust.

In one field of oats the effect of late planting and subsequent weather conditions on the amount of crown rust was noted Half the field was planted October 1, when rain delayed the work for ten days That planted early had the higher infection of rust, and the growth was stunted. That planted later was slower in receiving infection, which did little harm to the plants

There seems to be less rust this year than for many years This is probably largely due to the fact that through April and up to about May 15 there was very little rain

The stem rust was found in most localities, but in very small amounts, usually less than 1 per cent, and then mostly on low, wet land

The crown rust was present in every oat field visited, the stem rust in only a few, at least in appreciable amount Neither rust was recorded in epidemic proportions during the season of 1915

TEXAS. In 1904 stem rust reported as bad.

E. C. Johnson in 1911 reported oat rust.

In 1915 crown rust reported. First appearance, April 19, period of most damage, mid-April.

VERMONT. In 1905 Prof. L R. Jones reported that considerable oat rust was seen, but perhaps not more than an average amount.

UTAH. In 1909 stem rust was observed in Emigration canyon.

VIRGINIA. In 1909 Prof. H. S. Reed reported crown rust as locally abundant; 30 per cent of the crop injured in one county. Earliest report, May 15.

WASHINGTON. Report for 1912 by Dr H B. Humphrey States that crown rust was common, causing injury to 1 to 25 per cent of the crop. Earliest report in June. Owing to our usual dry summers, the grain rusts are not serious; this year, however, owing to unusual rainfall, rusts were severe.

WEST VIRGINIA In 1905 Prof. John L. Sheldon's report was as follows: "Oat rust was so bad in one field in Monongalia county that the plants did not head out and most of the straw was not worth cutting for fodder. Another field but a short distance away and on higher ground was not rusted and produced a heavy crop of grain. Damage from rust in general has been small and good yields are reported."

In 1906 Prof. John L. Sheldon states that loss from rust this year was greater than last (as reported in eight counties).

In 1912 stem rust reported as severe in two counties.

In 1912 crown rust said to be abundant late in the season on volunteer plants.

Crown rust reported also in 1914.

In 1915 rust generally prevalent.

WISCONSIN. In 1903 Prof. R. A. Moore reported both black stem rust and red rust.

In 1905 Professor Moore reported considerably less stem rust than in 1904; 1 per cent of crop injured. Weather conditions not favorable—dry and cool weather during early portion of growing period. Early-grown crop is freer from rust than late. In portions of the state where rust is generally prevalent farmers have been advised to grow barley and have quite generally adopted this plan.

In 1906 Professor Moore reported stem rust as somewhat less than in 1905, 2 per cent of the crop being injured. Weather conditions not favorable—dry and cool weather during early stages of development. No remedy has yet been found to keep the rust in check. Oats rust much more severely in some sections of the state than in others; most severe in the southern portion, where it sometimes reaches such an advanced stage of severity that the crop is entirely destroyed.

In 1907 Professor Moore reported oat rust as more prevalent than in 1906. Per cent of crop injured, 85. Earliest report, July 1.

In 1908 Prof. A. L. Stone reported crown rust as very prevalent; 10 per cent of crop injured. Estimated loss, $375,000. Weather conditions very favorable.

In 1908 Professor Stone reported stem rust as prevalent; 20 per cent of the crop injured. Estimated loss, $750,000. Weather conditions favorable. For the last two years abnormal spring weather has prevailed, but rust has been no worse than for five years back.

In 1909 there was less stem rust than in 1908. Weather conditions were favorable for the crop. Dry, hot weather ripened it off nicely.

In 1910 Prof. L. R. Jones and A. G. Johnson reported stem rust as much less than usual; practically none. Dry weather held rust almost perfectly in check.

In 1911 stem rust was abundant on late crops; earlier crops escaped owing to dry, warm weather

In 1912 stem rust was general; weather conditions favorable

In 1913 10 to 20 per cent of crop was injured.

NOTES ON OAT RUSTS IN EACH STATE

In February, 1916, a questionnaire* was sent to each state agricultural experiment station and to men in charge of cereal field stations of the United States Department of Agriculture The notes which follow are from the replies received, and indicate great variation in geographical distribution and seasonal occurrence of the two rusts. Much more careful study in the various states and thorough field surveys are needed to strengthen our knowledge of the two rusts of oats.

The questionnaires contained requests for information on the following points:

1 Importance of the oat crop in your state
2 Types most commonly grown·
    Winter—
        Red Rustproof
        Winter Turf.
    Spring—
        Early
        Mid-season
        Late
            Side panicle.
            Open panicle.
3. Usual date of sowing, heading, harvesting.
4 Occurrence of the two rusts (crown rust and stem rust)
    Date usually first reported.
    Frequency of occurrence:
        Ordinary infection.
        As an epidemic.

* Credit is due the station men who furnished the replies, and grateful acknowledgment is here made for the assistance given.

5. Which rust seems to be the more injurious?
6. In your opinion, does either of these rusts cause sufficient injury (average and epidemic years) to constitute a "limiting factor" in oat production in any section or sections of your state? If so, give peculiar conditions existing there of soil, climate, cultural methods, etc
7. If any work on varietal testing for rust resistance has been done, will you kindly include a statement of results to date?
8. Field or station plat observations on rust resistance of varieties, comparison of types, relation to lodging, relation to soil types or other factors of environment.
9. Any points not covered above, such as the occurrence of alternate hosts, etc.
10 Reference to any publications issued

As in the case of the Plant Disease Survey notes, the material which follows is arranged according to states, alphabetically·

CALIFORNIA. Furnished by Mr. E. L. Adams, of the Biggs Cereal Field Station, Biggs, Cal.

1. Oats in California have not been one of the leading cereals grown, but the acreage is slowly and steadily increasing The acreage of oats in the state has been a little more than 200,000 yearly for the past eight years The acreages in the six leading counties in the production of oats in the state are· Stanislaus, 38,546; San Joaquin, 23,208; Merced, 19,843; San Mateo, 16,125; Madera, 10,569; and Santa Barbara, 9,494 The average yield is usually from thirty to thirty-five bushels per acre

2. Winter varieties are best adapted to central and coastal sections. The Red Rustproof and Red Algerian varieties are usually grown in the central section, and the Red Rustproof and common California Black oat in the coastal region

Spring oats are not as well adapted to the central and coastal sections as the winter-sown. Spring oats are grown in sections having a high elevation and late spring rains The Sixty-day is one of the best varieties for spring seeding.

3. Usual dates of sowing, from December 1 to February 15; spring seeding, March 1 to April 1, heading, May 1 to 20, harvesting, June 1 to 25.

4. Stem rust has been noted in the Sacramento valley but it is not common. It occurs frequently in the coastal section, but the writer has never observed it. Rust is usually first reported May 1 to June 15. The infection in the Sacramento and San Joaquin valleys does little damage. Considerable damage has been reported in the coastal section during some years.

5. The writer is not familiar with the rust in the sections of the state where it frequently occurs. Stem rust is the more common in the central section of the state.

6. In the coastal section of the state warm fogs during the fruiting period of cereals are conducive to rust attacks. Rust constitutes a limiting factor in this section of the state in oat production.

COLORADO. Furnished by Otto A. Reinking, College of Agriculture, Fort Collins, Colo. The data were supplied by the Department of Farm Crops. Only general data regarding rust were kept.

1. In northern sections and high altitudes the oat crop is of considerable importance. Grown as a grain crop and as a forage crop. Frequently mixed with field peas for forage. In southern sections not of much importance. Grown mainly for feed

2. The Red Rustproof oat is grown in the Arkansas valley from spring seeding. Spring varieties grown are: Early, Kherson; mid-season, Colorado ,No. 37, Colorado No. 13, Swedish Select; late, White Russian. Nearly all varieties grown are of the open-panicle type.

3. Usual dates of sowing, early April; of harvesting, July and August.

4. Only in unusually wet years do we have much rust. During season of 1915 rust was reported from a few sections, but definite information cannot be given.

6. Rust is severe in some years, but not a limiting factor; there are no data as to which rust is the more serious one.

Notes furnished by G. A. McMurdo, of the Akron cereal field station, Akron, Colo.

1. Oats are third in importance among the grain crops and second in importance among the spring-sown grains. The acreage in oats is slightly larger than that in winter wheat and

about one-third larger than that in spring wheat. It is about 60 per cent of the total wheat acreage. The acreage in corn exceeds the acreage in oats by less than 10 per cent.

2. No winter types are commonly grown. Spring types are as follows: Early, large percentage; mid-season, in favored localities; late, only in limited sections; side panicle, small percentage; open panicle, large percentage.

3. Usual dates of sowing, March and April; of heading, July 1 to September 1, depending on altitude; of harvesting, August 1 to November 1.

4. Rust is of minor importance as a crop-limiting factor with the better varieties at Akron. No crown rust so far as I know. Stem rust appears July 1 to 15; oat varieties that mature late are more subject to rust Ordinary infections are not usually serious. This rust does not occur as an epidemic to my knowledge Stem rust seems to be the more common and injurious one.

CONNECTICUT. Furnished by Prof. C. P. Clinton, botanist of the Agricultural experiment station, Storrs, Conn. Data on the importance of the oat crop and on varieties supplied by Prof. W. L. Slate, of the Storrs station. Professor Clinton states that no special study has been made of oat rusts in Connecticut, as they have not been as important as some of the other diseases.

1. According to the census of 1909, 60 per cent of the farms in Connecticut reported corn and 12 per cent reported oats The number of acres of oats in the state that year was 10,207, the yield per acre was 26.8 bushels. Only 1 per cent of the improved farm land in the state was sown to oats More oats are grown than the census shows, since it is often harvested for hay. In general importance oats rank rather high. In money value they rank fifth, hay, tobacco, corn and potatoes exceeding it.

The acreage sown will undoubtedly increase in the next decade, and the Storrs station is preparing to meet the demand for information relating to varieties (pure strains only if possible) and methods of culture Litchfield county offers the best possibilities, and at present grows three to five times as much as the other counties.

2 No winter types are grown. Spring types grown as follows Most growers sow "oats." Clydesdale and Banner found somewhat, these are medium early Side-panicle types are occasionally grown, but the open-panicle types are generally found.

3 Usual dates of sowing, middle to late April, sometimes early May, of heading, late June to early July, of harvesting, late July to early August.

4 Crown rust is not uncommon Stem rust is found at least occasionally But few observations made and only a few collections on this host in herbarium.

5. The stem rust seems to be the most injurious, if we take into account its weakening action on stems, causing oats to lodge more easily. Thaxter, however, reported crown rust as being most destructive. The crown rust is probably the more common There have been no complaints from injuries caused by oat rusts, but there probably would be with a greater acreage sown to this crop.

9. The æcidial stage of the stem rust on barberry has been found a number of times, especially on wild species. The æcidial stage of the crown rust *Rhamnus* has not been reported, so far as I know, from this state.

GEORGIA. Furnished by Prof. B. B. Higgins, botanist of the Georgia experiment station.

1. In 1915 there were 905,000 acres sown to oats in Georgia; in 1914, 450,000 acres. The average yield was about 20 bushels per acre; the value, 66 to 70 cents per bushel.

2. Winter types are most commonly grown. Red Rustproof is a common variety; Winter Turf is very little grown Other varieties grown are Appler, Hastings, Bancroft, Fulghum and Virginia Turf. The first three belong to the Red Rustproof group. Spring oats are still less commonly grown. There is usually a very small acreage of Burt oats.

3. Usual dates of sowing: September 25 to October 25. Heading: Fulghum, April 22, (1915); Red Rustproof, May 3, (1915); Turf, May 10, (1915). Of harvesting: Red Rustproof, last week in May; Fulghum, May 17, (1915); Turf, June 4, (1915).

4. Rusts seem to be of very little importance on the early-maturing winter oats which are grown in this region. During the past two seasons no rust has been collected on oats, nor has it been reported by any farmer in the state.

NOTE.—Conditions may be different, however, in the coastal plain region.

IOWA. Furnished by Dr. L. H. Pammel, botanist at Iowa State College.

1. Iowa ranks ahead of all other states in oat production, and the crop is of first importance, except for corn

2. Spring types are the only ones grown, as follows: Early, 50 per cent; mid-season, 45 per cent; late, 5 per cent; side panicle, 1 per cent; open panicle, 99 per cent

3. Usual dates for sowing, early, March 21 to April 25, or till early May in northern Iowa; dates of heading, June 1 to first week of July; of harvesting, July 4 to first week in August.

4. (*a*) Crown rust is much more common than the stem rust, in most seasons, 5 to 10 per cent. (*b*) Stem rust, generally less than 5 per cent

Rust is usually first reported from the middle of June to the first of July In 1915 it was first noted on June 17 A few leaves were rusted perhaps a week earlier

Frequency of occurrence Ordinary infection, some rust occurs every year, as an epidemic, only occurs on late oats when climatic conditions are favorable

The crown rust seems to be the more common and injurious one of the two species

6. The rusts of oats constitute a limiting factor in parts of the state under peculiar conditions of culture, as follows (1) Soil Low ground (2) Climate This is the most important. (3) Cultural methods, etc Cultural methods do not seem to influence rust, so far as my observations go Prof L C Burnett thinks it has no influence.

Relation to lodging · If oats lodge they will rust more severely Generally oats lodge, and then they rust badly, probably because the moisture conditions are more favorable

Relation to soil types or other factors of environment The richer the soil the more rust, because the tissues are more easily infected That has been my experience over a long period of years

9. There are few alternate hosts in the state. Where the alternate host occurs, more rust is said to occur I have been told that in Butler county the oats leaf rust is always more severe close to the buckthorn hedges

KANSAS. Furnished by Prof. L. E Melchers, pathologist, Kansas State Agricultural Experiment Station.

Winter oats are not grown Early varieties of oats most commonly grown, of the open-panicle type. Red Rustproof (Red Texas) probably most common variety, Kherson second.

Usual dates of sowing, March 15 to 20, usual date of heading, June 1, usual date of harvesting, July 1

Crown rust of oats occurs probably annually in Kansas Some years it is more prevalent than others. It has been rather abundant last year (1915), especially on the sheaths. In the vicinity of Manhattan reports show that it is present by June 28 Specimens sent in October 15, 1915 (young plants), showed its presence

No epidemic of stem rust has been observed or reported in this state A few specimens were gathered at Hays, Kan, on June 17, 1914 It was observed on a few specimens in Manhattan in June, 1915, and in October, 1915

Oat rusts probably occur annually to a slight extent in various localities in the state, but have never been reported as an epidemic

The crown rust is very prevalent, being more common than the stem rust, but what its damage is cannot be stated Apparently the crop does not seem to be reduced by its presence.

Neither of the rusts of oats is of economic importance in the state

MAINE. Furnished by Prof. W. J. Morse, of the Maine agricultural experiment station. Data on varieties and dates of seeding furnished by Dr. Frank M. Surface.

1. Of the agricultural crops of Maine oats are reported as ranking third as a wealth producer; annual yield, about 6,000,000 bushels. In the better potato-growing districts, particularly in Aroostook county, oats follow potatoes in the rotation, then one or two years in grass and clover, and then back into potatoes again.

As compared with other parts of the country, Maine, according to my observations and from all that I can learn, as a rule suffers comparatively little damage from oat rust, except with certain varieties like the Senator, which are little planted. It is possible, however, that some seasons rusts of oats may be of greater economic importance than we have thought. Compared with certain other plant diseases, it has not seemed of sufficient importance to

merit any particular attention on our part. Consequently the data furnished are not as comprehensive as might be desired.

2. No winter types are grown Spring varieties commonly grown are: Early, Kherson; mid-season, Swedish Select, Banner; late, Early Pearl. All open-panicle types, no side oats is grown.

3 Usual dates of sowing: Northern, May 15; central and southern, May 1. Heading: Northern, about July 15; central and southern, about July 1. Harvesting: Northern, September 10, central and southern, August 20

4 Crown rust is not in our collection from Maine, but this should by no means be taken as an indication that it is not here

Stem rust is common and widespread, but, as before stated, it does not, as a rule, do a relatively large amount of damage upon the varieties generally grown

Date usually first reported: No data on this point

Frequency of occurrence: Ordinary infection rather common: not epidemic.

5 Apparently black stem rust is the more common and injurious of the two. Neither of these oat rusts are serious enough to constitute a limiting factor in crop production.

The Department of Biology of this Station has been giving special attention to oat-breeding work for several years and has grown a large number of named varieties and crosses of its own making The Senator is about the only one of these which Doctor Surface remembers especially as being attacked by rust My own recollection is in accord with this.

MINNESOTA. Furnished by Prof. Andrew Boss, agronomist, and Drs. E. M. Freeman and E. C. Stakman, pathologists.

1. The oat crop is probably second in importance of the cereals in 1915. An acreage of 3,125,000 acres was grown, which yielded 134,375,000 bushels Only two states, Iowa and Illinois, exceeded this production Owing to the increase in live-stock production in the state, there is a growing demand for the coarse grain crops, and oats stands next to corn as a feed crop.

2 Types most commonly grown Swedish Select, Archangel, White Russian, and Kherson types under many different variety names Winter oats are not grown.

Spring varieties commonly grown are Early, Kherson, Early Champion; mid-season, Swedish Select, Archangel; late, White Russian Practically all of the oats grown in Minnesota are open panicle. The Improved White Russian is sold by some seedsmen as a side-panicle oat. Some of the Garten introductions also are side panicles

4 Crown rust is practically always present, at least to some extent, and is probably the more important of the two rusts

Some stem rust is usually present, but seldom in sufficient amount to cause damage. Date usually first reported, about June 20 to July 1 A little of both rusts practically always present Neither usually is present in epidemic form The crown rust more often approaches epidemic condition

5. The crown rust seems to be the more injurious, and is also probably the more common, although the stem rust is usually also present

The rust of oats probably does not, at least in most seasons, constitute a limiting factor of crop production

Alternate (æcidial) hosts. *Rhamnus cathartica* (buckthorn) is commonly grown in hedges and commonly rusted.

MONTANA. Prof. D. B. Swingle, of the Montana agricultural experiment station, writes that the rusts of oats are extremely unimportant in Montana.

NEW YORK. Furnished by Prof. E. G. Montgomery, farm crops department of the New York State College of Agriculture:

1. Oats are our most important grain crop.

2. Types most commonly grown are medium maturing, branching, White Oats of Lincoln, or Swedish Select type. No winter oats are grown.

Of the spring varieties, early types are almost unknown. Practically all are mid-season, with a few late oats. Only a small part is side panicle; probably 99 per cent is open panicle.

4. Usual dates of sowing, last week of April in south New York, ten days later in north; of heading, July 10; of harvesting, August 11.

6. During the four years I have been in New York the rust has not been nearly as injurious as it usually was in Nebraska. Does not appear to be very injurious here, as a general rule.

Professor Barrus, of the plant pathology department, states that oat rust has been reported by farmers as causing serious loss in the northern counties of New York, but species is unknown.

NORTH DAKOTA. Furnished by H. L. Bolley, botanist of the North Dakota agricultural experiment station:

1. The importance of the oat crop in the state of North Dakota is second only to that of wheat; that is to say, the crop from year to year in money value and general acreage holds that position in this state.

2. Spring varieties are grown Named in order of their prevalence, they are: Swedish Select, Sixty-day, White Russian They say that the White Russian oat was for years the common form, but was allowed to degenerate because of poor grading. It is a very valuable oat in this region when properly handled. The Sixty-day oat is grown particularly, because it ripens early enough to escape rust attack and produces very heavy weight seed per bushel; particularly valuable because of the large size of the berry, though the grain with its husks do not indicate this. The Swedish Select, however, seems to be at the present time the hardiest and most satisfactory oat for yield and general market purposes; has rather heavy husks in proportion to berry. The weight per bushel still remains good.

3. The date of seeding will be from April 20 to May 25, or commonly along about May 10. Date of harvesting variable, according to growth season—July 25 to August 10, 12, or later, according to planting period.

4. (*a*) Crown rust is the common rust in this region; was not very destructive the past year. Should perhaps fairly be listed from 5 to 10 per cent or less for the general crop, there being cases of higher percentages due to planting out of season, etc. (*b*) Stem rust is often common in this state, but was not particularly destructive during the last year I would say that in most cases, for the general crop, it should be listed below 5 per cent of damage.

The ordinary first appearance of stem rust on oats will be seen in the neighborhood of May 15 to 30 The epidemic form will not appear until late in July

5. When the stem rust appears it is very much the most destructive, especially if it reaches the epidemic stage before the grain is mature One year with another, crown rust probably causes more damage, that is, it annually cuts down a small percentage of the crop, it being the most common form and usually present in more or less injurious form, resulting in injury by the premature ripening of the leaves or foliage

With our present knowledge, to specify definitely the soil, climatic or cultural methods or conditions which most largely influence the growth of either one of these species of rust is not possible. Apparently very much more depends upon some spring conditions which are unknown to me than to matters of culture, variety or soil Some years the rust gets started very early, and whether it is under dry climatic conditions for the most of the season, or whether extra wet, one cannot account for the excessvie development at certain periods and not at others on any other basis than it just chanced to be that in a particular region—perhaps it is one year a dry-soil region, as south and westward from Jamestown or north and eastward from Carrington, or another year it is the heavy wet lands of the valley—there is a heavy growth of either one or other of these rusts, particularly the stem rust. My explanation is that the moisture on the leaves and the spore distribution from barberry, or perhaps the red stage from another district, just chanced to furnish a good supply of spores at the time when the infection period was ripe. In my studies I have learned to know that the general infection does not come unless the oats chanced to be in the proper stage of development—just a matter of planting a few days late or a few days early. It is a problem worthy of very careful study for a number of years in which accurate data is compiled by the same observer on the same field under daily conditions.

7. In the case of oats we have not done sufficient variety testing work to justify conclusions. We have met with conditions similar to the ones we have indicated under question 6. Variety seems to be not of much importance under certain conditions which are unknown.

9. Most people do not give much credit to the destructive work occasioned by the ordinary common barberry bushes in the development and distribution and destructive effects of stem rust. Most people do not take sufficiently into account the distributing power of the wind and the long-extended vitality of æcidiospores and of uredospores. It does not take many barberry bushes to do the work over many miles. Our experiments and studies on this question are conclusive. The barberry bush is very destructive to cereal grains in the immediate vicinity, and we lose sight of this only because the wind distributes the spores over

miles of territory. There are plenty of barberry bushes in the state of Minnesota to largely account for the damage done in North Dakota, Iowa, South Dakota and Wisconsin. These are the only conclusions based upon our experimental observations which every year show the barberry bush to be most destructive.

Notes furnished by Mr. R. W. Smith, of the Dickinson substation:

1. The oat crop is next to spring wheat in importance.

2 Types most commonly grown: Mid-season varieties of white oats, as Swedish Select, Big Four, Silvermine A small acreage of Sixty-day type, and some late side oats. No winter oats are grown.

Spring varieties: Early, a small amount; mid-season, by far the larger part; late, a small amount. Side panicle, a small amount; open panicle, nearly all.

3. Usual dates of sowing, April 20 to May 20, averaging about first week in May; usual dates of heading, July 10 to 25, averaging about middle of July; usual date of harvesting, August 1 to 20, averaging about August 10.

4. A very slight amount of crown rust occurred in 1915. It appeared about August 10. A slight infection of stem rust in 1915. It apparently did not affect yield. Stem rust is rare in this section of the state. Ordinary infection probably about one year in three in eastern portion of state; as an epidemic very rare.

5. It is uncertain which rust is the more injurious. Did not distinguish the rust species when rust infections were observed.

6 There has been practically no serious rust epidemic at Dickinson (since the station was established in 1907) till 1915, when the wheat was badly infected, the oats only slightly. In Bottineau county (northern North Dakota) I have never observed a very serious rust epidemic (in fifteen years), but several light infections during that time. No relation between rust and lodging has been observed.

NEW JERSEY. Furnished by Prof. Mel T. Cook,* of the New Jersey agricultural experiment station.

1. Prof. Frank App, agronomist for the New Jersey agricultural experiment station, says: "The oat crop is of considerable importance in North Jersey, and is almost on a par with wheat. It, too, is used to some extent as a forage crop in the dairy regions. Its annual value is approximately $1,000,000, with an acreage of 70,000 and a production of 2,000,000 bushels"

2 Spring varieties are grown, mainly early or mid-season types

3 Usual dates of sowing, last two weeks in March and first two weeks in April; usual dates of harvesting, latter part of July and first part of August.

4. Crown rust is the most common and injurious one, infection 25 per cent to forty per cent. Stem rust very little; less than 5 per cent We have no complaint of rusts from farmers.

NEW MEXICO. *San Miguel county.* Furnished by M. R. Gonzales, county agriculturist, East Las Vegas.

1. Importance of the oat crop in San Miguel county. Five thousand acres in the county for 1915. There are more oats planted in the county than any other crop. It is a very poor practice, and we are discouraging the raising of such crop for the market. It is one of the main grains raised in all mountain districts.

2. Types most commonly grown: Colorado, No. 37, white oats; Swedish Select. Mixture of all kinds is two-thirds of all oats. Open-panicle types are commonly grown. Our seasons are so short that all our oats mature about the same time.

3. Usual dates of sowing, March 15 to May 15; usual dates of heading, July 1 to September 1; usual dates of harvesting, September 1 to October 1. I have not made sufficient definite observation on the subject to give desired information.

Colfax county. Furnished by V. L. Martineau, county agriculturist, Raton, N. M.

1. Importance of the oat crop in Colfax county: At the present time the oat crop is the most extensive grain crop grown in Colfax county. About 20,000 bushels were pro-

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* Professor Cook wrote as follows: "We do not look upon the cereals as of as great importance as the fruit, potato and truck crops, and therefore have given less attention to cereal diseases."

duced last year. The oat crop is likely to become less important, as yields are not large enough to make a reasonable profit.

2. Types grown: No winter oats are grown at present. Red Rustproof has been grown, but it is planted in the spring. A great many varieties of spring oats are grown here, about twenty different varieties being exhibited at our fair last year Early varieties are grown in the mountain and mesa districts; mid-season in irrigated and plains districts; late varieties in irrigated and plains districts; side panicle, Russian side oats; open-panicle type is most common

3. Usual dates of sowing, from the 1st of April until the latter part of May; heading takes place from the latter part of July until September 1, harvesting from August 1 until September 15.

4. Statement as to the occurrence of the two rusts (*a*) Crown rust. This type of rust is present, but not as common as stem rust. (*b*) Stem rust This type of rust is most common.

Date usually first reported: Usually appears during August

Frequency of occurrence Very common in all parts of the county (*a*) Ordinary infection is nearly always present. (*b*) As an epidemic Rust appeared as an epidemic this year (1915).

Stem rust is by far the most injurious here, and is the most common one

Rust is a limiting factor, especially in epidemic years. Nearly all of our soils are heavy clay loam. Sandy soils are red. Climate is cool on account of the high altitude here. Rains come during July and August.

The Russian side oat seemed to be more rust resistant than any other variety I observed.

OREGON. Furnished by Prof. G. R. Hyslop, agronomist of the Oregon agricultural experiment station.

1. The oat crop is the second cereal of importance in Oregon It yields from twelve to sixteen million bushels per year and the production is from thirty-five to forty-four bushels per acre The bulk of the oat crop is produced in the Willamette valley section

2. In western Oregon the open-panicled Gray Winter oat is very extensively grown. The early white spring oats of the sixty-day and Siberian type are commonly grown in eastern Oregon, while under most western Oregon conditions the mid-season or medium type, such as Swedish Select, Banner, Improved American, Three-grain and Victory, are more commonly used. The bulk of the crop of the state is of the open-panicled type In western Oregon there is some of the side-panicled type of the Shadeland Wonder, Challenge and Eclipse varieties Not many other side oats are grown. Practically all of the spring oats are white oats. The great bulk of the winter oats are gray oats, although in some cases there are some black oats and a few red ones

3. The usual dates of sowing winter oats are September 15 to November 1, although they are frequently seeded up to as late as the first of December, and often gray oats are seeded in January or early February Spring oats are seeded from mid-February until May 1, with the earlier dates of planting preferable. Oats of the winter varieties are usually harvested about the middle of July, of the spring varieties, during the first half of August.

4. I have not recognized the difference between crown rust and stem rust, but in my observations on the rust of oats I have noted that the leaf sheaths were affected very seriously as well as the blades, but have not noted such serious occurrence of rust on the stem itself. My observations have been that on all spring oats, seeded late, rust is much more injurious than on oats seeded early. Also in seasons that are rather warm and moist in June and early July the spring oats are seriously affected with rust; also the larger- and softer-stemmed varieties of oats appear to be more seriously injured than the finer- and harder-strawed types. The rust appears practically every year on some varieties.

5. Without having distinguished between the two varieties, I believe the stem rust to be the type which is most common and injurious with us

6. I do not believe that rust may be considered serious enough to become a limiting factor in most cases. In many instances it undoubtedly reduces the yield, but still our conditions here are such that we get pretty good yields of oats. I believe this to be largely due to the rather cool and moist climate which prevails during the early growing season and the cool and somewhat dry conditions which prevail a little later.

In seasons of warm, wet weather in June and early July the spring oats always show considerably more rust than in the cooler years.

Spring oats that are seeded late in the spring, or that mature quite late, are very likely

to rust much more seriously than the early to the medium varieties, with the exception noted in the answer to a previous question, that certain varieties appear to be less resistant to the rust.

7 Varietal testing of oats has been carried on for a number of years, more from the standpoint of getting yields than from the standpoint of resistance to rust Where pronounced rusting has taken place notes have been made of it, but not according to the scale adopted by the Office of Cereal Investigations It has simply been noted that certain sorts were very rusty or showed considerable rust In case of varieties which did not show the presence of the disease no particular note was made.

Of the various varieties tested the ones most seriously affected with rust have been Shadeland Challenge, Shadeland Eclipse and Shadeland Wonder I consider these three varieties to be the same, and as all of them are late, they are usually seriously affected with the disease Improved American and Banner also usually show considerable rust In a one-year's trial Black Victor and Black Beauty showed very serious rusting Of the varieties which showed considerable less trouble with rust, I may mention the Sixty-day and the Kherson (which appear to be the same thing), the Three-grain and the Shadeland Climax or Swedish Select. Of the winter oats I think the most resistant type to be the Gray Winter, and the Black Winter is a type of brown oat that has also proven to be quite resistant. I believe the Black Russian to be more seriously affected than any other type of the winter oats which I have had occasion to try

In my experience with oats there has been no difference in the rusting of the side-oats or tree oats, but it has been very largely along the line of large, sappy types and the smaller-strawed types, and also along the lines of earliness and lateness There has been no relation between lodging and the presence of rust, as conditions are such here that oats very rarely lodge

Notes of Prof. H. S. Jackson, formerly plant pathologist

Both the crown rust and stem rusts on oats occur in Oregon. I would not consider either one very serious, however, at least not in the Willamette valley I have noted the stem rust quite commonly, often collecting it on volunteer oats and on *Avena fatua glabrata* The crown rust I have found but rarely, though I suspect it is more abundant in the coast region I have only two collections in my herbarium

I would say regarding the crown rust, that no culture work has yet been conducted using material from the Pacific coast, so far as I am aware I am convinced from field observations, however, that the crown rust has for its æcidial host in western Oregon, *Rhamnus purshiana* The æcidium is very common and agrees well with the forms on other species of *Rhamnus*. The rust under discussion is noted much more commonly on several native grasses It would be impossible to say whether or not the strain which we find occasionally on oats comes from an infection of æcidiospores from *Rhamnus purshiana*

No æcidium has yet been collected on *Berberis* in Oregon, except the æcidium of *Puccinia kœleriæ* which occurs on *Mahonia* (*Berberis*).

PENNSYLVANIA. Furnished by Prof. C. R. Orton, pathologist, and Prof. F. D. Gardner, agronomist, of Pennsylvania State College.

1. The oat crop is surpassed only by corn and wheat in Pennsylvania
2. No winter oats grown Of the spring varieties, mostly mid-season varieties are grown. Early oats are becoming more popular. Mostly open-panicled oats are grown
3. Usual dates of sowing at the Pennsylvania experiment station, April 15-20; of heading, July 4-8; and of harvesting, July 24-28; in southern Pennsylvania about two weeks earlier and in northern Pennsylvania a week to ten days later.
4. Crown rust appears yearly, but from our records, beginning 1909, it appears to have done slight damage in 1911 and 1914. It was apparently severe in 1909 and 1910, and 1913 and 1915 in some localities.

Stem rust frequently occurs in the state, but not so prevalent as crown rust. Usually first reported in July. Stem rust was prevalent in 1908 and in 1910 locally. No epidemics reported of stem rust.

5. Crown rust much more prevalent, and apparently most injurious. Early oats suffer much less than late varieties of late-planted oats.
7. No variety testing for rust resistance has been done. Varieties have been tested for yield, but no records of injury caused by rust have been made.

9. Alternate stage of crown rust has been collected in Pennsylvania, and probably occurs infrequently on *Rhamnus cathartica*.

Using the scale furnished for estimating rust, I find that our collections of the crown rust show the following per cent of infection: 1908, about 40 per cent, 1909, 25 to 40 per cent; 1913, 40 to 50 per cent; 1915, about 30 to 40 per cent

SOUTH DAKOTA. Furnished by Mr. J. D. Morrison, of the Highmore sub-station.

1 Oats are an important crop in South Dakota, doing particularly well in cool, moist seasons

2. Winter oats are not grown. The following percentages represent the distribution of types of spring varieties. Early, 70 per cent; mid-season, 28 per cent; late, 2 per cent. With regard to form of panicle Side panicle, 1 per cent, open panicle, 99 per cent.

3. Usual dates of sowing, April 1 to May 1; of heading, June 20 to July 15; and of harvesting, July 15 to August 15

4. Crown rust usually is not very prevalent. Stem rust is the principal rust appearing in South Dakota, and the most injurious one. It is usually first reported shortly after heading. It occurs usually only in wet seasons. Ordinary infection, 0 to 30 per cent, depending on the season and the variety of oats. Late varieties are usually more severely injured. As an epidemic, 1 to 100 per cent, usually in wet seasons, when heavy dew is followed by an extremely bright, hot day. This continuing for a week or ten days reduces the resistance to rust and produces favorable conditions for rapid spore development

5. Soil seems to have very little influence on amount of rust Wet seasons, when a heavy dew is followed by a hot, bright day, if continued for a week or more, produce rapid development of rust Have noticed no influence of cultural methods on rust development.

8 Location has something to do with rapid development of rust. Wet, low ground usually shows more rapid development No observations on comparison of types, except that early varieties are more resistant The better word would be "evasive." Observation would indicate greatly increased lodging due to rust infection, especially in later stages of development. Climate seems to be the limiting factor in rust development

Notes furnished by Manley Champlin, assistant agronomist of the South Dakota agricultural experiment station:

1. The oat crop usually ranks third in value, corn and wheat surpassing it.

2. No winter oats are grown Types of common spring varieties are grown as follows: Early, Sixty-day; mid-season, Swedish Select and Silvermine; late, White Russian, in northeast section. With regard to form of panicle Side panicle, White Russian; open panicle, Swedish Select, Sixty-day and Silvermine.

3. Usual dates of sowing, April 1 to 30; of heading, July 3 to 10; and of harvesting, August 1 to 10.

4. Crown rust rather rare, apparently does little damage Stem rust is the most common and injurious form. Abundant, particularly in eastern section and on late varieties. Attacks both leaves and stems. Date usually first reported, June 20. Frequency of occurrence, common. Ordinary infection every season in eastern section; as an epidemic in wet seasons.

6. Rusts do constitute a limiting factor in oat growing, at least in the eastern section. Soil is medium sandy, glaciated loam varying in degree of sandiness. Precipitation, 20 to 25 inches; extremes of temperature to be expected. Summer weather frequently hot and muggy.

Often drilled on single-harrowed corn ground. Sometimes corn ground is double disked and harrowed before seeding. If oats are seeded after small grain the land is fall plowed and spring harrowed and the oats are drilled.

8. Often the weather conditions increase both rust and lodging, so that in the field it is impossible to say whether lodging is due directly to the weather or indirectly because of rust development. Rich loams with high organic content produce a rapid tender growth of straw, and therefore a crop more easily infected than the crop on poor soils.

9. There is considerable buckthorn and barberry grown for hedge and ornamental purposes, especially in the eastern part of the state. Wild barley is also plentiful, particularly in low, slightly alkaline spots. Occasional letters have been received stating that rust is more prevalent near groves than elsewhere. There are many small artificial groves in the state which were put in to secure title to the land under the old tree-claim act. These are frequently grown up to weeds and brambles, and I believe the wild barley found in such places is responsible for harboring rust spores.

TEXAS. Furnished by Supt. John F. Ross, of the Amarillo cereal field station.

1. The value of the oat crop for Texas is given as $3,700,000. It ranks ahead of wheat, but forms less than 1 per cent of the total value of the agricultural products of the state.

2. Winter Turf is one of the types of winter oats commonly grown. Spring varieties grown are late, open-panicle types

3. Usual dates of sowing for the "panhandle" region, March; of heading, last week in May; of harvesting, first week in July

4. Have had practically no trouble with rusts in oats in the panhandle No detailed data are at hand The crown rust seems to be the more common one

VERMONT. Furnished by Prof. B. F. Lutman, pathologist of the Vermont agricultural experiment station.

1. After the corn crop, oats are the most important grain crop of Vermont. In fact, corn and oats are about our only grain crops

Banner and Swedish are grown by many of the up-to-date farmers, and do well in this climate. The majority of the men, however, just sow "oats" The seed until recently was home-grown, but during the last ten years there has been a greater tendency to buy western oats for seed.

2. No winter oats are grown Of the spring varieties, types of the mid-season group are principally grown

3 Usual dates of sowing, as early as possible in April, average probably about middle of April. Usual date of heading, about middle of June Usual date of harvesting, early in July, rarely after the middle

Crown rust is fairly common both on the oat and on *Rhamnus* (buckthorn). Stem rust is our common rust, and the most injurious one. Date usually first reported, first to middle of June.

Frequency of occurrence There have been very light infections in recent (five to six) years Ordinary infection, about 10 per cent, in many cases not over 5 per cent. Neither rust seems to cause serious enough injury to be considered a limiting factor.

9 The æcidia have been almost absent from the barberry and *Rhamnus* during the past three years. I have found it difficult to get specimens, even for class use Our early springs have been very dry, also the middle of the summer

WASHINGTON. Furnished by E. F. Gaines, cerealist of the Washington State College.

1 The oat crop of Washington is second in importance of all farm crops, wheat being first. Until 1914 there has been a steady increase in the production of oats in Washington. There is only about one-half as much land seeded to barley as oats, and the wheat acreage is about five times that of both oats and barley

2. Very little winter oats are grown, perhaps 1 per cent of the total Of the spring oats it is estimated that 15 per cent are early, 75 per cent mid-season, and 10 per cent late. As to form of panicle, 15 per cent are side panicle and 85 per cent open panicle.

Usual dates of sowing, March 1 in Big Bend and River valleys, to May 1 in higher altitudes; heading, June 1 to August 10; harvesting, June 30 to September 1.

4. During my field trips last season I did not see a single case of rust on oats. A disease-survey record has been kept here for three years only, but during that time there has been no mention of the occurrence of rust upon oats. From this I am led to infer that the trouble is rather uncommon, especially in eastern Washington.

Notes by F. D. Heald, plant pathologist:

Saw no oat rust last season. Records for 1913 and 1914, the only ones available, contain no mention of oat rust. Oat rust would seem to be rather rare in this territory. This may not apply to western Washington.

6. Oat rusts may in some localities and seasons constitute a limiting factor in oat production on heavy, clayey soils and those soils very rich in humus, and where the climate is cool and moist. Cultural methods favorable to rust: Late seeding; seed bed poorly aërated.

8. Early varieties rust less than the later ones. The factors which cause rust seem to cause lodging, also, namely, overabundant humus supply, much moisture, late maturity.

WISCONSIN. Furnished by A. G. Johnson, assistant plant pathologist, and B. D. Leith, assistant agronomist, Wisconsin agricultural experiment station.

1. The oat crop is very important in Wisconsin; most extensively grown of any cereal crop. Practically every farmer grows oats.

2. No winter oats are grown Of the spring varieties the following types are grown: Early, small amount, mid-season, by far most commonly grown, late, very small amount, only in northern part of state With regard to form of panicle: Side panicle, very small amount in northern part of state, open panicle, by far most common

3. Usual dates of sowing, April 1 to 25; of heading, June 10 to July 4; and of harvesting, July 15 to August 10. These dates are for the southern and central sections; in the northern part they are two to three weeks later.

4. There is great variation in the occurrence of crown rust from year to year, and in different sections, also in different fields in same section, in general, 15 to 30 per cent

There is great variation in the occurrence of stem rust from year to year and in different sections; also in different fields in same section; in general, 10 to 50 per cent Usually first reported latter part of June to first part of July Ordinary infection each year As an epidemic, no regularity, in southern and central sections more or less in 1913 and in 1915; previously none noted (as epidemic), at least for five years

5 Stem rust seems the more injurious in cases where infections from both are parallel and equal, which happens sometimes in certain fields Crown rust is the more common (*i. e.*, general) one

6. Rusts are not usually a limiting factor in Wisconsin except very locally where soil is too heavily fertilized with barnyard manure, thus producing very heavy growth and consequently making conditions for infection very favorable

7. Very meager exact data as yet on varietal resistance Early varieties escape, *e g*, Kherson and Sixty-day Late varieties always rust badly, *e. g*, (1) side oats group, (2) *Avena sterilis* group "Rustproof" rusts badly in Wisconsin because of late maturity Heavy amount of rust and excessive lodging seem to be associated

9. Buckthorn not common in Wisconsin, therefore the æcidial stage of crown rust may be regarded as practically a negligible factor Barberry more common, and is undoubtedly one important factor in early infections Relations of the crown rusts of wild grasses to the form on oats need to be carefully studied

WYOMING. Prof Aven Nelson, botanist of the University of Wyoming, writes as follows.

No doubt these rusts occur to some extent in the state, but our dry atmosphere reduces their occurrence to a minimum Their rapid dissemination depends on warm, moist or muggy weather Such weather occurs occasionally in the lower altitudes, but here on the Laramie plains we have neither the moisture nor the warmth to make rust epidemics possible.

Furnished by V. H. Florell, of the cereal field station at Archer, Wyo.

1. The order of importance of the small grains is oats, wheat, barley

2. A small acreage of winter oats is grown in the mountain valleys of western and southwestern Wyoming. Spring varieties grown are of the open-panicle type, as follows: Early, Kherson and Sixty-day; mid-season, Swedish Select, Colorado No. 37, and Welcome.

3. Usual dates of sowing, April 15 to May 1; of heading, July 1 to 20; and of harvesting, August 1 to 15.

4. Oat rusts are of very little economic importance in Wyoming. A slight infection (— 1 to 1 + per cent) of what is thought to have been stem rust was observed on every variety of oats grown at Archer in 1915, excepting Probsteier (C. I. 495). Rust first observed at Archer about August 1.

GENERAL STATEMENT.

From the data at hand it seems clear that the crown rust is much oftener reported from nearly all sections of the United States, but that in some of the northern sections of the country the distinct and often severe losses are due to the presence of stem rust in the form of an epidemic.

In some sections, particularly the winter-oat states of the southeastern United States, and in seasons favorable for its development, however, the crown rust may be the cause of appreciable losses.

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Explorations of the Permian of Texas and the Chalk of Kansas, 1918.

CHARLES H. STERNBERG.

The splendid skeleton of *Dimetrodon gigas* I collected in 1917 and sold to the United States National Museum has been mounted at last, and is one of the world's famous specimens. I do not know of a more perfect single individual. It came from the famous Craddock quarry discovered by the late Doctor Williston's assistant, Mr. Miller. Through the kindness of Mr. Craddock, the owner of the quarry, I not only collected there in 1917, but last year. Owing to the fact that the quarry is now covered with about twenty feet of earth and clay of the toughest character the work was very difficult and I was obliged to employ a man with a heavy team of horses, with plow and scraper. I succeeded in securing many more or less perfect skeletons of several species. Unfortunately, none were as perfect and capable of making into a fine open mount as the National Museum specimen. This quarry is in the face of a hill. As I have gone deeper and deeper into the hill the manner in which the animals were stranded here becomes more and more apparent. On the very bottom of the quarry are innumerable bones of very small animals, Seymoriana and other batracians, etc. They are usually scattered and are free from matrix, consequently they are among the rarest of Permian vertebrates that have not been injured by the encrusting silica that covers all the other bones at higher levels, and which is so difficult to remove. The National Museum specimen came from near this level. Above are about four or five feet in the heavy, fine-jointed red clay. Though water has filtered and coated all the bones with silica, I found several more or less perfect skeletons. Often the entire column, except the tail, with enormous spines were present; sometimes the arches and limbs, as in the best specimen we found, discovered by my son, George F. The longest spine of this individual was four feet. Most of the column and tail were present. The skull was disarticulated. The arches seemed present. Many of the spines, however, were twisted and interwoven, all the bones covered with a thin coating of silica. As I understood Doctor Gilmour, it took two preparators a year to prepare and mount the National Museum specimen. You will realize something of the labor it will take to prepare this one. This, with my whole collection from the Craddock quarry, I sold to the American Museum.

From Seymour, Tex., my boys, George and Levi, drove my car to the Rock creek Horse quarry, near Tulia, Tex., but the formidable mass of sand that lay above it induced them to turn their Ford truck northward, and I joined them in the Kansas chalk in Logan county, on Butte creek. I was so fortunate as to find a fine tylosaur skeleton the second day in the field. There were twenty-one feet of the skeleton present in fine chalk. The complete skull was crushed laterally. Nearly the complete front arches and limbs were present, as was also the pelvic bones and both femora. All the vertebræ to well into the caudal region beyond the lateral spines were continuous, with the ribs in the dorsal region. Between the ribs was a large part of a huge plesiosaur with many half-digested bones, including the large humeri part

of the coracoscapula, phalanges, vertebræ, and, strangest of all, the stomach stones, showing that this huge tylosaur, that was about twenty-nine feet long, had swallowed this plesiosaur in large enough chunks to include the stomach. How powerful the gastric juice that could dissolve these big bones! This specimen I sent to the United States National Museum A little *Clidastes* skeleton found by my son Levi proves not only to be new, but possessed of remarkable characters not yet described. I will only in a general way give you an idea of this lithe sea lizard. It is 8½ feet long, skull 14 inches long. Levi in preparing the skeleton restored the maxilla, jugals, nasals and prosquamosals, with the ends of some of the teeth; also four of the cervical and one dorsal vertebra These had been destroyed by incrusting gypsum. The bifrucated coracoids, 2 inches wide, are large compared to the scapulæ, which are only 1¼ inches wide. The most remarkable thing about this mosasaur is the fact that the humeri and femora have distinct, round heads, similar to those of mammals. Further, all the *Clidastes* humeri I know are broad, square bones, nearly as broad as they are long. In this specimen the humerus is 2¼ inches, while it is only 1¼ inches wide in the widest part; the same with the femur. The front paddle is 7 inches long to ends of first row of phalanges; width only 2½ inches. The column is continuous to the pygals, where they are scattered The pelvic arches and paddles are only partially preserved. The caudals are beautifully preserved, with a high fin in the last half of the column; the chevron well preserved, with all of them anchylosed to the centra of the vertebræ. The only genus among the mosasaurs where this is the case. They usually are distinct, the proximal heads fitted snugly into little basins hewn out, as it were, from the centra of the vertebræ. I own this new *Clidastes*.

We secured two specimens of *Platecarpus coryphæus* of exactly the same size. One found by Levi Sternberg has much of the head, the column, and ribs to the pygals The second, found by George F. Sternberg, has a very complete tail to the very end, and the pelvic arch and one paddle; other specimens furnished the rest of the paddles. We have mounted this as a slab specimen, and makes a skeleton 17 feet long—very impressive, indeed.

George F Sternberg found also a very fine skull and most of the skeleton of a small *Pteranodon*. The skull is only 27 inches long; missing, only the crest and front of the mandibles. Both coracoscapula are present, with one humerus, radius, ulna, carpal joint, and most of one elongated finger. Both hind limbs and several vertebræ and ribs. This, when prepared, will be one of the few fine skulls of these flying reptiles. We secured also a very fine *Portheus*, complete, nearly, except the ends of the ribs, the dorsal and caudal fins, and 18 caudal vertebræ. These we have restored, and we have a fish 13 feet long, with spread of tail fins of 35 inches. These are the chief discoveries of my last season's labor in the Permian of Texas and the chalk of Kansas.

Botanical Notes for 1918-1919.

FRANK U G AGRELIUS

NOTES ON THE UNUSUAL SEASONAL ACTIVITIES OF CERTAIN PLANTS, 1918-1919

Continuing our annual practice begun in the latter part of 1915, we herewith give a list of plants exhibiting unusual seasonal activities—usually that of blooming, and so understood unless otherwise stated. These were observed by the author of the article in or near Emporia, Kan, exceptions being noted. As before, the plants are arranged, where possible, according to Gray's Manual, seventh edition. The list follows

Asparagus officinalis L On market second time October 25, 1918 Our own were being used by us about October 21, in bloom November 17

Ulmus americana L In flower (?) January 28, 1919, buds nearly open (flower) February 1, 1919

Cerastium brachypodum (Engelm) Robinson November 4 common November 6, 13, 20, abundant December 4, 14 22, February 1, 1919 February 17

Aquilegia canadensis L Second time July 25, 1919

Alyssum maratimum Lam October 26, December 14, 22

Lepidium virginicum L (?) November 7, 14 (flower and fruit)

Capsella bursa-pastoris (L) Medic November 6, 13, 14 (flower and fruit) 19 (Katy tracks)

Brassica nigra (L) Koch (?) November 19 (Katy tracks)

Spiraea japonica L var *callosa-alba* (?) October 18, 26

Spiraea bella Sims (?) November 6, 14

Spiraea trilobata L var *van houttei* August 13

Pyrus communis L (Bartlett?) Some flowers frosted good stamens December 12 good stamens December 14

Pyrus malus L October 14 Near Wellsville, Kan Reported by Miss Rita Marley

Pyrus japonica Thunb November 26 (flowers frosted some)

Rosa sp (A wax rose) November 10 Alma reported by Miss Ora Fridley

Trifolium pratense L November 13

Trifolium repens L November 4, 13, 19 (froze night before)

Melilotus officinalis (L) Lam October 26 November 14, 19 (Katy)

Melilotus alba Desr November 4, 6, 19

Medicago sativa L November 4, 16

Medicago lupulina L November 6

Linum sulcatum Walt (?) Yellow flowered, in Stannard pasture, October 17

Pelargonium zonale Willd November 19 (east of house, and uncovered)

Acer saccharinum L February 4, pistillate flowers out wide, K S N campus Saw staminate flowers out, but frozen, on Thirteenth street, February 11 Same flowering again February 13 blizzard by evening Same kind blooming again February 17 Noted bees out

Malva rotundifolia L November 19 (Katy tracks)

Viola pedata L October 29, November 4

Viola cucullata Ait October 18, 25, November 4, 6, 10, 19 (Katy), December 19 Reported by Lieutenant Crosswhite

Forsythia viridissima Lindl December 14, 22

Syringa vulgaris L September 17, in full bloom at home of Mrs Ruth V Winey, seven miles north of Newton, Kan

Asclepias (?) sp Found a green pod of a member of this family lying in the road on Eighteenth street This is evidence, of course, that it had bloomed much out of season November 19, 1919

Lycopersicum esculentum Mill October 20

Solanum rostratum Dunal November 12

Viburnum opulus sterilis L. October 26 One "ball" on a bush.

Solidago sp. November 19 (Katy tracks).

Aster sp. November 19 (Katy tracks).

Erigeron ramosus (Walt.) B. S. P. November 7.

Erigeron canadensis L. November 14.

Achillea millefolium L. November 19 (Katy tracks).

Taraxacum officinale Weber. November 14, about full bloom in some places. January 8, 12, snow thawing but a little way from it. January 12 to 16, continuous blooming. January 25, doing well; normally open; bees on one. January 30, fairly numerous flowers. February 17, open well. Seed appeared to be matured in each of the fall and winter months

Sonchus asper (L) Hill. November 14, 19.

Solanum tuberosum Linn. Mr. McNeely brought me a tuber taken from the ground February 27, 1919 It had formed from a potato left in the ground during the winter. It was a "new" potato, with the characteristic thin skin, easily rubbed off. It was about ⅝ of an inch in diameter. It was similar to those often formed in cellars. It had probably escaped freezing by a snowdrift covering it during the more severe weather.

Forsythia viridissima Lindl. April 2, 1919. The lower part of the bush at our home is full of bloom, to the height of about eighteen inches. The rest of the plant is bare of flowers We ascribe this to the fact that snow covered it to about this depth during our severe cold weather of the winter. A privet hedge near it caused the drift. This suggests a fact to keep in mind in locating this shrub in our climate. It is beautiful when it blooms, but there are too many springs when it does not bloom freely. We observed another specimen with perhaps half a dozen flowers very close to the ground, and from probably the same cause as ours, only with a shallower snow protection

FURTHER NOTES ON "POTATO SEED."

In our notes for 1917 we called attention to the question of potato seed and its scarcity. During the past year we noted some fairly well-developed seed balls on some of our potatoes. They were probably Red River Early Ohios. We had a few Irish Cobblers. The balls did not contain any mature seeds. However, we have since noted in seed catalogues potato seed for sale in plenty. In an article in the *Literary Digest* of the present volume is a picture of some potatoes grown from seed. They vary very much in size, color, worth, etc. When these are again planted they will show better what is in them. The possibility is that there may be a potato of some worth appear, and so the experiment has some interest.

AN EXPERIMENT WITH CERTAIN TWIGS IN WINTER CONDITION.

The following twigs were collected on or about ——— and placed in water in tumblers or other glass vessels in our laboratory. The water was renewed as it evaporated or seemed in need of renewal for any reason. By April 7 some had sprouted or formed roots. The data has a bearing on the likelihood of some plants to form roots from shoots when kept in water for a time. A list of all of the plants thus tested follows. After this is a list of those that did form roots, with their relative ranking as to the relative abundance of roots formed.

Pinus austriaca Hoss.
Thuja occidentalis Linn
Juniperus virginiana L.
Smilax rotundifolia L.
Salix fragilis L.
Salix amygdaloides Anders.
Populus alba L.
Populus deltoides Marsh.
Juglans nigra L.
Carya cordiformis (Wang.) K. Koch.
Betula alba L.
Quercus macrocarpa Michx.
Ulmus fulva Michx.

Ulmus americana L
Celtis occidentalis L
Maclura pomifera (Raf) Schneider
Morus rubra L
Menispermum canadense L
Ribes gracile Michx
Platanus occidentalis L
Spiræa trilobata L var *vanhouttei*
Spiræa prunifolia Sieb & Zucc
Cratægus mollis (T & G) Scheele
Rosa sp (Dorothy Perkins rambler)
Prunus americana Marsh
Gymnocladus dioica (L) Koch
Gleditsia triacanthos L
Cercis canadensis L
Amorpha fruticosa L
Ailanthus glandulosa Desf
Rhus glabra L
Acer saccharinum L
Acer negundo L
Vitis cordifolia Michx (?)
Tilia americana L
Hibiscus syriacus L
Cornus asperifolia Michx
Fraxinus pennsylvanica Marsh var *lanceolata* (Borkh) Sarg
Syringa vulgaris L
Syringa sp
Forsythia viridissima Lindl
Symphoricarpos orbiculatus Moench
Sambucus canadensis L

The following started roots more or less abundantly and readily

Sambucus canadensis L Slightly
Ulmus fulva Michx Slightly
Populus deltoires Marsh Slightly
Populus alba L Slightly
Hibiscus syriacus L Slightly to fairly
Vitis cordifolia Michx (?) Well
Symphoricarpos orbiculatus Moench Well
Salix amygdaloides Anders Well
Salix fragilis L Very abundantly and readily (best of all)

The above results were noted in the course of a study of twigs in their winter condition by a plant nature-study class

FURTHER NOTES ON POLYCOTYLEDONY IN CERTAIN PLANTS

At the session of the Academy in 1918 we gave some notes along this line. We can add some slight progress We have an abundance of seed from a specimen of castor bean plant that showed the above phenomenon. We are expecting to plant some of this seed this spring, and will note results. We also noted three cotyledons in two tomato seedlings this spring, and have them marked and hope to obtain seed from them for further experiment

The Banana as a Food Product.

J. M. McWharf.

Much of vital importance has been and is being said about conservation along all food products. Many articles have been and are being brought forward as substitutes for wheat, meat, etc. Very little of value has been said about the banana—an important food product.

We have here a fruit containing a large per cent of the carbohydrates; hence an important staple food. The ash of the banana contains a large per cent of the phosphates, sulphates and chlorides of potash, soda, magnesia and lime, all of which are essential in body economy. It lacks in protein and fats. A free use of milk with the banana will reduce the amount of meat necessary for body needs. There being a close proximity between the potato and banana, we could readily drop the potato from our dietary list without deleterious results. The banana contains approximately 20 per cent more fuel in food value, as shown by analysis.

It might be of interest to compare the banana with the potato

	Potato	Banana
Water	78 8%	75 8%
Protein	2 2%	1.8%
Fat	0.1%	0.6%
Carbohydrates, including fiber	18 0%	22 0%
Ash	1.0%	0 8%
Calories, per pound	385	460

In a paper of this character, as much as it might be desired to make a comparative analysis of a large number of foods, we find it next to impossible to do so.

In our study of essential food products we must keep constantly before us the distinctive difference of heat-giving and tissue-building products. Meats are protein foods—tissue builders. They make good the losses due to the wear and tear of body machinery. The banana produces the carbohydrates that keep the machinery in running order. The best all-round food, then, would consist of the banana coupled with a small amount of protein foods. The edible portion of steak contains 65.5 per cent of water; haddock, 81 to 82 per cent; while the banana contains 75.5 per cent. The meat and fish, however, contain a greater per cent of protein. It is found upon analysis that the banana ash contains silica, 2.19 per cent; lime, 1.82 per cent; iron oxide, 0.18 per cent; phosphoric acid, 7.68 per cent; magnesia, 6.45 per cent; soda, 15.11 per cent; potash, 43.55 per cent; sulphur trioxide, 3.26 per cent; chlorine, 7.23 per cent. Here we find a large per cent of base-forming salts, which are so essential.

Essential body food must contain nonnitrogenous substances to develop energy, and nitrogenous ones for repair of tissue waste. The amount of protein food should not exceed 15 per cent, for we have no storage for it as is the case with fats.

Age and manual labor performed will determine the amount of fuel food needed. During the period of growth children burn their food up more rapidly, and as the banana is a high-power fuel producer for the body, besides being rich in the desirable salts, base-forming minerals, it is of great value as food for the child.

The banana flour, of which little is known in the United States, is said to be very nutritious. The banana can be used in a variety of ways—baked, boiled, fried, served as chips, French fried, etc. In all of the ways suggested, they are excellent in taste and highly nutritious. If used as vegetables they should be taken before the full period of ripeness. At this time they contain more starch and less sugar. If thoroughly ripe it is easy of digestion. Some are of the opinion that if dark brown spots are visible the fruit has reached the point of destruction; but this condition simply means complete ripeness.

Now, the time required for digestion of some other foods as compared with the banana is an important factor. The ripe banana will be digested in 1 hour 40 minutes; tomato, 2 hours 5 minutes; beans, 2 hours 30 minutes; green peas, 2 hours 30 minutes; oatmeal, 3 hours 5 minutes; boiled potatoes, 3 hours 30 minutes; turnips, 4 hours; cabbage, 4 hours 30 minutes; roast mutton, 3 hours 15 minutes; roast beef and soft-boiled eggs, 3 hours 20 minutes to 3 hours 30 minutes; boiled beef, 4 hours 15 minutes; roast pork, 5 hours 20 minutes; apples, 2 hours 20 minutes; mackerel, 4 hours; nuts, 4 hours. You will please note that 1 hour and 45 minutes is the time necessary to digest the banana, and it contains more nutrition per pound than fish or vegetables It provides more food than any single fresh fruit, vegetable, fish, milk or eggs, and it is a staple food for universal use. The banana is an important food, easily digested—in fact, more so than fish or vegetables.

The facts are, we do not up to this hour fully understand or appreciate what the banana has in store for us as a food product. Its wealth cannot be measured by dollars and cents.

It is evident from figures given that the banana produces more food for the same cost than any fresh fruit, vegetables, fish, meat, milk or eggs. The table given below shows the caloric value per pound of the edible portion of the banana as compared with many of the foods in common use and upon which we depend for subsistence:

	Calories.		*Calories.*
Banana	460	Oysters, solids	230
Spinach	110	Scallops	345
Green peas	465	Haddock	335
Onions	225	Flounder	290
Squash	215	Halibut	470
Parsnips	300	Blue fish	410
Cabbage	145	Chicken	505
Green corn	470	Pickled tripe	270
Fresh Lima beans	570	Oranges	240
Beets	215	Grapes	450
Macaroni, cooked	415	Figs	380
Boiled oatmeal	285	Cherries	365
Asparagus	105	Apples	290
String beans	95	Milk, whole	325
Clams, raw	240	Round steak, medium fat	450
Lobster	390	Round steak, lean	540
Carrots	210		

There are but seven out of the thirty-three given in the above table that equal or excel the banana, and three of these are so close that they need not be referred to.

Eat more bananas, drink more milk, and use in this connection apples quite freely, then use, in a small degree, meats of all kinds, and you will be kept in a far better physical condition.

Probable Eocene Glacial Deposits in the Fort Apache Region, Arizona.[1]

ALBERT B. REAGAN.

When the writer wrote his geology of the Fort Apache region, Arizona, much uncemented gravel and bowlders were found capping the mesas and underlying the lava flows. These deposits he placed in the Tertiary and Quaternary. In his section at Canyon creek, Arizona, from the source of that stream to its confluence with Salt river, he gives 125 feet of coarse, uncemented gravel of gneiss and quartzite bowlders capping the clastic rocks. Gilbert's section at the crossing of Canyon creek in that region, which he copies, also gives 20 feet of coarse, uncemented gravel of quartzite and gneiss bowlders.[2] Some of the writer's other sections in that region are here copied in whole or in part to show the existence of this material in the various parts of the reservation, as follows.[3]

Section in Seven-mile Hill canyon, five miles southeast of Fort Apache, Ariz.

		Feet.
1.	Basalt	200
2.	Volcanic ashes	10
3.	Strata of mostly unlithified sands and clays	40
4.	Shale, light colored, sandy	4
5.	Conglomerate rock, the cement being volcanic ash, the pebbles and cobblestones of this series being quartzite, granite, andesite, rhyolite, limestone of the Paleozoic era, etc. (no cobblestones or pebbles of the basaltic type was found in this conglomerate).	
6.	Strata of partly lithified, coarse-grained, reddish to light brown sandstone, composed of angular and rounded grains of granite, rhyolite, etc. In this series the rhyolite-trachyte particles predominate	60
7.	Carboniferous, red gypsiferous shales, with sandstone and limestone	800
	Total	1,814

Section along east wall of Cherry Creek canyon, Arizona, seven miles north of Salt river, near Mr. James Hinton's house:

		Feet.
1.	Light to dark-brown rhyolite	30
2.	Conglomerate rock	80
3.	Tufa agglomerate	20
4.	Light-gray sandstone	10
5.	Rhyolite	30
6.	Gray sandstone and conglomerate	100
7.	Fine-grained, gray to brown sandstone, composed of ground-up Archæan and Paleozoic rocks, granite, rhyolites, diabases, etc	40
	Total	310

1. For references on this region the reader is referred to the following:
G. K. Gilbert and A. R. Marvin; U. S. Geog. Sur. West of the 100th Meridian, Vol. 111, and special references as follows: Gilbert, pp. 163, 164, 165, 526-528; Marvin, pp. 221-223.
Oscar Loew, ibid., pp. 587, 642.
Albert B. Reagan; Geology of the Fort Apache region in Arizona: Am. Geologist, Nov. 1903, pp. 265-308, 2 maps, 1 plate.

2. Gilbert, ibid., p. 164; Reagan, loc. cit., p. 270.

3. Reagan, ibid., pp. 270-275.

Apparently all Tertiary.

Section south of White river, three miles west of Fort Apache.

		Feet.
1.	Basalt	200
2.	Unlithified volcanic ashes	10
3.	Loose strata of slightly litified clays and sands	40
4	Carboniferous, red gypsiferous shales with sandstone and limestone	1,000
	Total	1,250

Generalized section on the government trail from Ellison's to Canyon creek:

		Feet.
1	Adobe clay	8
2.	Loose cobblestones and pebbles	1
3.	Yellow clay interstratified with loose sand	4
4	Cobblestone stratum	1
5.	Light yellow to pink, lithified, stratified rock, composed of fine grains of Archæan and Tonto rocks	10
6.	Dark-brown, partly lithified sandstone	1
7.	Yellow to brown and pink cross-bedded sandstone	10
8	Conglomerate series	20
9.	Porphyry, gneiss and granite rocks (intrusive)	100
10.	Tonto sandstone and shale	500
11.	Archæan (?) hornblende biotite granite, olivine diabase and hornblendic diorite	500
	Total	1,155

Section on Carrixo creek (after Gilbert):[4]

		Feet.
1.	Coarse gravel composed of vitreous sandstone quartzite and gneiss bowlders	50
2–7.	Clastic rocks	1,370
	Total	1,420

Section north from near Camp Apache (Fort Apache) (after Gilbert):[5]

		Feet.
1	Basalt and basalt gravel	70
2.	Pale pink slightly coherent, massive sand and gravel resting unconformably on No. 3	520
3–6.	Clastic rocks	1,670
	Total	2,260

It is quite possible from the data at hand that the deposits have accumulated in Seven-mile Hill section and in the Salt river and Hinton regions and in many other places in the area covered by the paper throughout the Tertiary, and may have begun even earlier. A part of the series which the writer had originally designated Tertiary, principally in the sections mentioned above, begins with a consolidated, coarse, conglomerate stratum, beneath which are strata of partly lithified sands, clays and gravels reaching a thickness of nearly a thousand feet in thickness in some places. The formation is found, for the most part, in the ancient canyons of the region. Conformably on the formation above designated Tertiary in this paper, and in my original report on the region, are hundreds of feet of unconsolidated gravels and clays, and occasionally volcanic ashes. This series covered the entire region, excepting, possibly, the Ellison dome, so that the lava flows which closed the Quaternary flowed

4. Gilbert, loco cit.; Reagan, ibid., p. 274.

5. Gilbert, ibid., p. 165.

over a plain. Since then much has been removed, so that now it is patchy, except where it is protected by superimposed lava. It now fills the valleys of the Pinal and Apache mountain districts, the volcanic and plutonic rocks projecting above it as peaks and mountains. The middle Cherry Creek valley and the Tonto basin, as well as the Ellison flat, are covered with it. It covers the Mogollon mesa, together with its southern prolongations, including the Cibicu divide, to a thickness from 500 to 1,000 feet in many places. It is the surface rock of much of the Kelley butte country, and extends beneath the lava of the Nanatan plateau as far as visited.

At the time of the writer's studying the region he believed that these deposits were due to a laking stage, due to differential uplift and lava flows, as he found no striæ markings; but since his study of the glaciation in the San Juan mountains in Colorado and the Deep creek region, Utah, he has been compelled to change his views and conclude that the deposits in question are of glacial origin and caused probably in part by laking, due to glaciation and volcanic disturbances. This view is also borne out by the fact that the Cibicu divide and the Mogollon mesa, which are both heavily covered with this drift, are higher than the surrounding country and show no evidence of a laked stage.

The deposits, clays, sands, gravels and boulders of schists, quartzites, gneisses, carboniferous rocks, vitreous Tonto sandstone, diorite, trachytes and Archæan rocks indicate different development centers of the glaciers that swept over the region. The material of the Seven-mile Hill deposits and that beneath the lava flows of the Nanatan plateau indicate that they came from the White mountains to the eastward, as do also the depositing dip of the clays and sands. But the deposits of the Cibicu divide indicate by their composition that they came from the west and northwest, as do also the Hinton and Salt river deposits, being composed of quartzites, gneiss, vitreous Tonto sandstone, Archæan and Paleozoic rocks and biotite granite, all of which are exposed in the upper Canyon creek region, the Ellison dome and the Tonto basin. It is also quite probable that some of the debris came from the mountains to the northward.

From the inadequate data at hand it would seem that at least the deposits below the partly consolidated conglomerate series are Tertiary, extending to the early Tertiary, as Gilbert, Marvin and the writer concluded when examining the region, and the remainder Quaternary, as was then concluded. This being the case as the facts at hand seem to indicate, we would, therefore, have glaciation here in early Tertiary times, probably in the Eocene period, repeated again in the Quaternary. Laking in consequence of blocking lava flows and faulting, probably played its part, as did also the subsequent development of drainage, which is in part inverted and in part diverted.

As a closing remark: The finding of glacial material forming the opening series of the Eocene in many parts of the world brings again to the fore the fact, with emphasis, that glacial epochs have occurred at the beginning (or the close) of each of the great eras of geologic time.[6] This brings up the question again, Why do geologic eras close? Is it not a cosmic cause? And, as the writer has suggested in previous publications, may not these changes,

6. See Atwood; Eocene glacial deposits in southwestern Colorado: Professional Paper 95, B, 1916, pp. 13-26.

both in climate and in readjusting and rebuilding of the earth's crust, be due to causes brought about by our solar system having reached one or the other termini of the great ellipse around which he is whirling his company of planets, meteors, planetoids, secondary planets and comets, as our extreme yearly seasons are caused by similar positions of the earth with reference to the path it travels around the sun [7]

Glacial Deposits in Pine River Valley, Colorado.

ALBERT B REAGAN.

The table flats at Florida, east of Durango, Colo, on the Denver & Rio Grande railway, on east across Pine river to beyond Spring creek, at La Boca, on that railroad—in fact, the whole area from the bluff mesas west of Durango to the bluff mesas beyond Spring creek to the eastward, in a curve running to the northeast of Durango, bending far to the southward and southeastward—is covered heavily with glacial drift, though the country rocks project above it in points, ridges and buttes in many places The mesas southwest of Ignacio are also covered with glacial boulders and other glacial material. How much farther the glacier extended is unknown to the writer.

A little northeast of Durango, in the Animas valley, there are heavy morainic deposits,[1] associated with extensive outwash deposits. The same phenomenon appears on the Florida above and in the vicinity of the station of the same name. At Oxford the outwash material, loess, etc, is ten feet deep, superimposed on a bed of boulders often from ten to twenty feet in depth. West of Ignacio the outwash material butts up against the mesas, being often twenty feet thick in the valleys. At Ignacio and at the Southern Ute boarding school, a mile to the northward, the outwash upper till-loess-adobe clay is from five to ten feet deep back from the mesa's edge of the first bench. Immediately underneath this is from five to twenty-five feet of boulders, underlain in places with lower till. At La Boca only outwash material was seen, there often forty feet thick as is shown in the valley cuts of the present washes. Three miles north of the present Indian school on Pine river the stream has cut completely through the debris, which here shows no lower till, but twenty-five feet of boulders, on which is superimposed outwash till and loess. The bench west of the Indian boarding school, to which a part of the school lands extend, is 100 feet above Pine river in elevation, but at no place in the slopes from the river to its crest was the original rock shown. On top of the bench is five feet of adobe, beneath which is twenty-five feet of boulders, beneath which is till to an unknown thickness. At Bayfield, ten miles north of Ignacio, the outwash material is of immense thickness, overlying boulders, while to the southeast of that city, over a small ridge of jutting country rock buttes, is a pocket of glacial deposits of a similar nature. Also from Bayfield northward on Pine river for many miles outwash material is very conspicuous; the valley fillings seem to be composed wholly of it.

The glaciers that made these deposits seemed to have two or more centers.

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7. Reagan; Causes of the glacial period: Trans. Kansas Acad. Sci; and Sunspot, vol. 1, No. 11, pp. 18-30; January, 1916.

1. See Atwood; Prof. Paper 95, B, pp. 14, 15.

The glacier in the vicinity of Durango seems to have come down the Animas river channel. The rest of the glaciers seem to have had their origin in the lake country above the junction of Vallecieto creek with Pine river in the high peaks of the San Juan range. Rushing downward from the heights, they seemed to have had a collecting basin in the Vallecieto district of the upper Pine, now a magnificent valley from a mile to several miles wide and several miles in length, blocked in by mountains and ridges which rise 1,000 feet above the valley floor, now the summer resorts of the Millers, Boyls and Kilpatricks. Here the glacier pushed southward, spreading out both eastward and westward into a huge fan as it reached the valley flats, even crawling over the lower ridges of the foothills and beginning to spread extensively before reaching the latitude of Bayfield. At this writing the writer cannot say whether the Spring creek glacier was a branch of the Pine river glacier, or was produced from another glacier center in the same mountains. This much is sure: At La Boca they formed a continuous ice sheet and the outwash material coalesce.

As the boulders overlie the mesas south of Ignacio, it would seem that they were carried there when the glacier was higher and more extensive than when it deposited the great boulder deposits in the lower benches at Oxford, northeast of Durango, at Ignacio, and in the lower valley of the river near the latter place. Whether two glacial stages are here represented could not be determined with the data obtained.

Since glacial times the river and confluences have cut entirely through the drift at most places all the way to bedrock, and have also widened out a very considerable inner valley flood plain

Plague Among Chickens in Central Iowa During the Summer of 1918.

ALBERT B REAGAN

While the writer was visiting friends in Story, Jasper and Polk counties, Iowa, in the summer of 1918, it was noticed that the chickens had a very peculiar disease. All the chickens were more or less sick with cholera symptoms, but those which were affected the most were the young chickens. These would probably be looking all right, when suddenly they would begin to droop. After an hour or so, or in some cases a day or more, they would become erratic and fidgety. They would then hold their wings out from their bodies and gradually straighten up as they trembled from head to foot; and in many cases examined, the skin became puffed up and much distended from the rest of the flesh with a sort of gas, so that one could see through the puffed skin like looking through an inflated bladder. As the inflating proceeded the sufferer gradually tipped more and more backward, till in many cases it finally fell over backward and died.

The acting was so singular that the writer went to investigating the disease to find out the cause. It was soon found that it was the food they were getting that was killing them. These were the findings:

1. Chickens fed on anything but corn did not get sick.
2. Chickens fed on two-year-old corn did not get sick.

3. Young chickens fed on two-year-old corn kept well, but when that feed was used up and they were then fed on the last year's corn, they immediately took sick and began dying.

4. Young chickens fed on the last year's corn mostly all died.

It was then learned that the corn crop of 1917 never rightly matured; in fact, in shelling it off of the cob there was seldom an ear whose grains were not moldy at least at the point end. This was the secret of the disease conveyed to the chickens—the toxic principle of the mold had caused the chicken plague, the same as the toxic principle of the mold on the grass in Nebraska killed the horses there some years ago, and the same principle of the mold on the wild rice at Nett Lake, Minn., caused the scourge of cholera infantum at that place in the fall of 1913

The "Flu" Among the Navajos.

ALBERT B REAGAN

The writer arrived at the western Navajo agency, Tuba City, Ariz., October 3, 1918, to take charge of the Marsh Pass boarding school, which he found to be still eighty miles farther on to the northeast. He had come direct from Washington, D C, via Flagstaff, to take the position, and while on the trip he found the papers filled with accounts of the ravages of the Spanish "flu"—cantonments were suffering, Boston, Mass, was prostrate, and so on. Arriving at Flagstaff, he found the state normal closed on account of an outbreak of the disease One of the professors of that institution had died of the disease On arriving at Tuba City, two members of the agency force were not feeling very well, but no one realized that they were suffering from the "flu" On October 12 we proceeded on through Marsh pass—and "a pass" is right—and on to the Indian school of the same name, twelve miles farther to the northeast, at the little settlement and post office called Kayenta, accompanied by several agency employees, one of whom got very sick en route. On the 14th the agency party returned, the sick official being in such bad shape and with such high fever that it was with difficulty that he was returned to the agency at all. After the departure we began to make preparations for opening the school on October 21

Up to this time no one knew that the people who were feeling badly had the "flu," and though we had read much about the ravages of the disease, none of us realized its deadliness. But the day we left the agency Dr. N. O. Reynolds, the agency physician, began to suspect that the Indian children at the boarding school at that city were taking the disease, and before the sun had gone to rest on that night he had a dozen youngsters in the hospital. In three days practically every pupil at the Indian school was down.

On October 18, at 11 a.m, an auto from Flagstaff, 180 miles away, arrived at the school with an order from Doctor Reynolds, instructing me to close my school and proceed at once with the whole school force to Tuba City, to take care of the school at that place, as practically every one was prostrate there. As per order, we had a hurried dinner, threw a few things into a suit case, and at 1 p. m. started for Tuba. It was a bad day. We passed through showers of rain, sleet, hail and snow and chilling winds in descending from the pass. Without mishap we arrived at Tuba City at 7 p. m. and found the

conditions as bad as represented. They were so bad that the automobile driver at Flagstaff had been phoned to get us, as no one could be spared at Tuba to come to Marsh pass. Indian Agent Walter Runke was not expected to live; Mrs Butler, the Missionary's wife, was dying; nearly all the other employees were sick, and 59 Indian boys and 79 Indian girls at the school were down. As soon as we could get a lunch we took immediate charge, my wife taking charge of the girls' dormitory and myself the boys'. I relieved a man whose whole family was down with the disease, and my wife relieved a sick matron who was taking care of sick children while suffering with a high fever. Twenty-three of my boys were frothing at the mouth, and some were delirious, one little fellow getting completely out of doors twice that first night. Added to my troubles was the fact that as every one was down with the disease, sanitary conditions had gotten very bad, as many of the children were wholly helpless, and added to this was the children's occupying different rooms on different floors, and the cooking establishment, where all the nourishment had to be obtained, was quite a distance away in another building. Not only that, but on account of the shortage of help I had to help carry the food to the sick in the girls' dormitory, as well as look after the sick in my own. I blistered my feet by step climbing. Neither myself nor my wife got the disease, and, luckily, too, Doctor Reynolds kept his health and was able to work almost day and night, which he cheerfully and faithfully did. It might be well to add here that every employee of the government at the school and agency did all that was in their power, working even when sick to save the children. After something like a week other employees began to convalesce, so they were able to relieve us some; and then help came from Flagstaff, which relieved us of the night work and some of the food carrying. In the meantime two of the girls died, both at night, and on account of the Navajos' fear of death and the dead, we had to carry them out of the dormitory as soon as dead, with lights darkened so the other pupils could not see what we were doing; otherwise we likely would have had a worse stampede than when a wolf gets into a chicken house. We also made the coffins and buried the pupils in the early hours of the morning, for the same reasons. The Indian children never knew that there had been a death among them till after they had convalesced. No Indian boy died at the school at the time, but one John Navajo has since died from complications due to the "flu." Three white people also died in Tuba and vicinity.

The Hopi village of Moencopi, two miles southeast of Tuba, has approximately 300 inhabitants. Of these, 181 were sick at one time. Miss Elizabeth Ruth, one of my employees, an educated Moqui, was detailed to help take care of her people at Moencopi, aiding Mr. Curn, the day school teacher, and Mrs. Ruhl, the field matron. But unfortunately the field matron was already sick in bed when Miss Ruth got there, and three days later she also took down with the disease. Consequently Mr. Curn was overwhelmed with the task. At this critical time some well-meaning but misguided nurses came out from Flagstaff, and, not understanding the Indian character, got the village mad, so that the Indians refused to receive any attention from them or take any medicine administered by them, the medicine men and other dignitaries following them around as they went about the village, forbidding the people to take their medicine. They apparently did not try to relieve the sick people in any other way.

The Flagstaff people giving up the task as hopeless and the help at the school being now able to control the situation there, I went to Mr. Runke and Doctor Reynolds and got permission to take over the work at Moencopi, where I was heroically aided by Mr Curn in every way possible. When I arrived at the village I found there were whole families who had not had a bit of cooked food for six days, and even eight days; one family of six had eaten only a half a melon in five days. Coming back to the agency, Doctor Reynolds and myself took the government auto and went into the hills to search for some sheep to kill, as the school was out of meat at the moment. We found some sheep, but as the shepherd was not the owner we could not purchase one, so we had to motor some five miles further to find the owner, a Hopi Indian. Getting the sheep, I prepared twenty gallons of soup in the school kitchen and proceeded to the village by auto with it. On taking the soup to one of the houses where a lone widow and two children lived, the woman burst into tears and said, "Is that for us? How thankful I am, as my children have had nothing to eat for three days, and I was so sick I could not hold up my head." The next morning one of these little children frequently asked his mother when the good "American" was coming, and when I arrived he had his face pressed against the pane, watching expectantly. Given food and reassured, but few refused to take medicine, and in a short time most all in the village had convalesced. Of the 300 who were sick only 16 died.

But dealing with the Navajo is quite different. He has never been under very severe discipline of the government He is a nomad in the full sense of that word. He is like the Irishman's flea; he is here to-day, but to-morrow where will he be? Like the Arab, he moves about with his flock of sheep, goats, horses and a few cattle. He may be in a certain canyon to-day and miles from there in another canyon to-morrow, as the scarcity of water and grass necessitates He has but little or no furniture, and but few traps of any sort In some places he may cultivate a little corn and raise a few melons, which is about the extent of his farming. He has no permanent abode, and his shelter extends from a brush corral to a dirt-covered, cone-shaped hogan, which is always destroyed when any of its inmates die. Also, like the Arab, he is very independent by nature and wishes to be left alone. Moreover, his own medicine man ministers to his needs of medical attention and prepares him for the land of Indian bliss in the hereafter.

As soon as the people of Moencopi began to convalesce Doctor Reynolds, Mr. Stewart and myself took the auto and went to find the Navajos. Reaching the settlement known as the "Fields" in Moencopi wash, we found it abandoned. We then followed the Navajos as far as Mohave, where the missionary told us they had all fled toward Navajo mountain and Black mesa with their flocks at the breaking out of the disease in their camp. The next day Dr. Grady Shytles, a special government physician, arrived, and plans were at once perfected to visit every settlement on the reservation and establish nurse-medical service at each place, principally at Blue Canyon, Red Lake, Kaibito and Shanto. Also hearing that the disease had reached Marsh pass, my wife and myself returned, November 4, to that place, accompanied by both doctors. Arriving there we immediately turned the school into a hospital, which was soon filled with the sick, for people were sick and dying everywhere. Soon then nurses and other help was brought to us from the agency at Tuba, as dire necessity demanded.

When the disease struck the Navajos they fled from the places where it appeared, often abandoning everything in their panic, even their sheep in one instance. One Indian man is also alleged to have abandoned his sick family, a wife and several children, to die of starvation, and several families are said to have abandoned their sick members. The fatality of the disease was astounding. Whole families were wiped out, leaving their sheep wandering about over the hills to run wild at the mercy of the coyotes Several related families living together all died but one twelve-year-old boy, who was found herding the combined flocks of sheep, and now it is said the agent at Shiprock, under whose jurisdiction he belonged, is making efforts to have the boy inherit the combined flocks of sheep he saved from the wolves. At another place a family of eight were picking piñon nuts when the disease overtook them. When found later they were all lying dead around their wagon A Piute woman died, and the father and five children crossed the San Juan into the Navajo country with their sheep, when they were overtaken by the disease and died one by one along the trail, only one small boy surviving—so small that he could not tell what his parent's name was. A Navajo by the name of Bill found him wandering about aimlessly and took him to his hogan near here. The sheep were probably all lost. The wife of an Indian by the name of Ralph gave birth to a baby girl while sick with the "flu" Five days later it became evident that she would die from the effects of this disease and from blood poisoning. As soon as it was seen that she would die, she and baby were at once abandoned. Later the baby was found by the agency party, and it and its mother, who was still alive, were brought to the hospital at the school, but the mother died that same evening, and the little one had been so starved that it succumbed two days later, though it was not sick with the "flu." There are also other instances where the wife died and the husband abandoned his children to perish by the dead mother In one case reported to the writer a husband abandoned his dead wife and several children, all of whom starved to death. Among Navajos, if the mother dies the children are virtually orphans, though the father survives, as they are not considered his children but the children of the clan to which the mother belonged. Moreover, he inherits none of his wife's or his children's property in case of their death, the same diverting to the clan of the wife.

During the "flu" epidemic many dead were abandoned and left unburied. Others were left where they died, in the hogan, and were simply covered with a few shovelfuls of dirt right where they died The writer found such a burial in several hogans, and one in the only really well-constructed house of a Navajo he has seen on the reservation—a well-put-up stone structure. In their panic, after throwing some dirt over the corpse near the fireplace, where she had died, they fled and left the door open. Seeing me, they begged me to go and shut the door for them, which I did. Many dead were left unburied where not close to government employees, or trading posts. The Indians were so terribly afraid of the dead, or so weakened by the disease themselves, that they fled from the "death hogan," begging the whites to bury their dead. If there were no whites in the vicinity they were left unburied. The writer helped bury three Indians that were found abandoned unburied. The Kayenta policeman was buried by a government party after he had been dead in an abandoned hogan eight days. Such were the terrible ravages of the disease.

It might be well to add here that the Navajo country contains 25,725 square miles, an area larger than Connecticut, Rhode Island, Massachusetts and New Hampshire combined; and for the purpose of administration is divided into the following reservations: Pueblo Bonito, San Juan, Navajo, Navajo Extension, Western Navajo, and Hopi. The population is estimated at 30,000. It might further be added that this write-up extends to other reservations than the one to which the writer belongs as an employee.

On November 5, in company with Mr. Clyde Caldwell and John Straus, the agency stockman, we skirted the east side of Black mesa for sick people. We buried three people, two of whom were abandoned dead that we found. Burying the Indians and looking after the wants of the sick brought night upon us on a road trail we had never seen before, and that with an auto. About 7 p.m. we got a sick Indian and started to the school hospital wtih him. After traveling about half an hour the lights on the auto burned out and we were left in absolute darkness. We then walked ahead to find the road, but missed it some place in the darkness, finally coming onto a corral It had been snowing and misting all afternoon, and, with a deathly sick man, we were in a horrible plight, as we could find no road leading from the corral. We got a fire for warmth and as a landmark, so we would not get lost from the auto while looking for the road We then made torches from cedar bark which we pulled off of the poles of the corral. With these we circled the corral till we found the road, which was about half a mile to the westward Then by riding on the running board and holding the torches in front of the auto we finally reached the school with the patient

The next morning one of our patients died. Up to this time I had had the patients only in the boys' dormitory Upon hearing the death wail I rushed into this dormitory. Pandemonium had already taken possession of the sick there before I arrived With wild eyes they were starting to leave the "place of the dead", even a sick man who could scarcely hold his head up the evening before was out of bed, trembling from head to foot. Aided by Mr. Caldwell and Mr George M. Post, I got them from the room into the girls' dormitory. But that afternoon an old medicine man sent them word that they would all die if they stayed there, so one by one they were all taken away by their relatives. In two days, however, I had the dormitories filled again, finally getting all the old patients back.

The man who died we wrapped in a red blanket. We had no lumber to make coffins with, as we were approximately 200 miles from the railroad. With him we started the Kayenta graveyard. As time went on more died and were similarly buried, nine of the hospital patients dying Remembering our first experience, when one got dangerously sick we separated him from the others, placing him in the boys' dormitory; and when one died we buried him at night, so as not to arouse the superstition of the Indians any more than necessary against the "place of the dead," as they began to call the school plant. In all, four men, two women and three children died at the school hospital.

When sick the Navajos think one should be fed much—at least much meat. If he cannot eat it is expected he will die. Stuffing in sickness is common, and often is the cause of much trouble and not a few deaths. Mr. Greene, who had charge of the medical work at Kaibito during the "flu" epidemic,

told the writer that he knew of cases where the sick one was too weak and sick to eat, in which case the well ones made meat balls about the size of one's thumb and forced them down the patient till he was "full up to his chin." Such stuffed patients usually died. When sick the Indians also often give the patient the juice of the Arizona jimpson. This makes the pulse run high and causes delirium, and usually is administered as a last resort. It is reported that it was much used in doctoring the "flu"[1]

In doctoring for the "flu" at Kaibito the Indians killed horses and made horse-tail soup as a remedy to cure the sick, which, by the way, was a good thing, as it helped get rid of some of the worthless ponies. The main remedy, however, was the powow Yavapai ceremonies, accompanied by elaborate sand paintings. The paintings, usually made in circular form, are drawn in a hogan, all the household but the patient being moved out, usually to a brush-corral wind protection. The drawing is then made around the central fire, usually in concentric bands, whose separating rings are usually rainbows. The figures of human-mythical beings, called "chindes," are the crude figures of the interband spaces Each medicine man seems to have his own system of drawings, though, on the whole, they are very similar. The drawing must be made and used the same sun. When completed, the nude patient is daubed all over with a medical concoction of charcoal and other medicinal ingredients of the Navajo. He is then placed either on or near the drawing. At one which the writer visited the patient was placed just to the west of it; in another he was sitting on the central figure. Then elaborate singing and praying follows, the praying sounding much like Catholic people saying the rosary. The medicine man's part, on account of its repetition, resembles the Jewish prayer, "Our Father Abraham, Isaac, Jacob," etc. As a faith cure this is a good remedy, but it will not cure the "flu.' This failing, the final and last remedy was a massaging, contorting process. As the disease usually terminated in pneumonia, and consequently the lungs were tight, the medicine man jumped on the afflicted parts to loosen them up. The result can be imagined. The special physician came upon a medicine man doctoring an Indian by the name of Gladhand by this process, with dire results to the Indian medicine man before the doctor got his ire soothed.

Below is a list of the Indians who have died of the "flu" within a radius of twenty-five miles of the Marsh Pass boarding school.

Clazien Begay, male, age, 45, widower

Eshin Sosies' wife, age, 30 Four children, ages, 9 years, 4 years, 2 years, 6 months. Husband survived

Waie; male; age, 30

Asthon Elseesee; female; age, 40 One child; age, 14 years

Aosteon Ganeten Begay, male; age, 12

Aosteon Ganeten Begay, male, age, 8

Nelthinie Begay, male, age, 4.

Nelthinie Begay, male; age, 5 days.

Kay Bitse; female; age, 42. Five children; ages, 18, 16, 14, 12 and 7 years

Asthon Hunnagonic Begay; male; age, 16.

Glad Hand, male; age, 26

1. This medicine is also given to persons when going into a trance. It makes them "see things." It is reported that one time here at Kayenta a certain Indian stole some property. The medicine man went into a trance while under the influence of this weed, and coming out of the trance state he prophesied (told) who had the goods, and it was alleged that the property was at once returned. The juice of this plant is used in many medicine ceremonies.

Tom Holiday's wife age, 50 Husband survived
Tom Holiday's daughter-in-law age, 20 One child, age, 2 years Husband survived
Tom Holiday's daughter-in-law age, 18 One child, age, 10 days Husband survived
Hosten Tas, male age, 38 Three children, ages, 2 years, 1 year, 10 days Two wives survived
Doten Betsoil male age, 37 Two children ages, 3 years, 3 months Wife survived
Tazhie male age, 35 Two children ages, 3 years, 1 year Wife survived
Aiskinnmee Beg female age, 35 Three children ages, 10, 7 and 5 years Husband survived
Belin Ihlicien Beg's four children and grandson one year old
Sayetsissy Begay male age, 12
Tolchacone male age, 30
Tolchacone Bitsilly male, age, 16
Tolchacone mother age, 50
Tolchacone grandmother age, 70
Tolchacone sister age, 16 Husband survived
Nockai Begay male age, 25 Two children ages 5 and 3 years
Nockai Begay's wife age, 25
Nockai Begay's daughter age 7
Asthon Behsteer's wife age 24 Two children ages 4 and 3 years Husband survived
Asthon Behsteer's daughter age, 10 days
Pecho Bitse female age 40 Four children ages 14 years 7 years 3 years, 6 months Husband survived
Kitsie Pie Begay son age, 3
Nedocloie Bedony male age 35
Nedocloie Bedony child
Nedocloie Bedony's child
Nedocloie Bedony's child
Nedocloie Bedony's daughter's child
Otizy Clizhen's daughter age 18
Otizy Clizhen's daughter age 15
Otizy Clizhen's daughter age 10
Aotehe Mez female age 18
Euchigie's son age, 4
Euchigie's daughter age 6 months
Belin Clizhnmie Beti's child male age, 18
Belin Clizhnmie Beti's child female age, 12
Belin Clizhnmie Beti's child female age, 10
Belin Clizhnmie Beti's child age, 6 months
Belin Clizhnmie Beti's brother's wife's daughter age, 8
Yadelgood's child female age, 6
Hasten Yazzie's brother's two children
Ason Stellie's child male age, 5
Leonard Thomas wife age, 20
Leonard Thomas's daughter
Leonard Thomas daughter
Leonard Thomas son
Leonard Thomas' wife's sister
Hosteen Betsisie Betse female age, 35 One child age, 15 days Husband survived
Hosteen Betsisie Betse's daughter, age, 18
Hosteen Betsisie Betse's daughter, age, 12
Hosteen Betsisie Betse's son age, 10
Hosteen Betsisie Betse's (wife) age, 30
Hosteen Betsisie Betse's daughter, age, 9
Hosteen Betsisie Betse's son age, 7
Hosteen Betsisie Betse's daughter, age, 5
Adakie Bidony, male, age, 25
Adakie Bitse, female, age, 15
Hosteen Doctin Betsoie, female; age, 3
Hosteen Clee Betatis, female; age, 8
Ason Clizzie Betsoie, male, age, 6 months
Asthon Huddledruteg Begay, male, age, 30 Wife survived
John Nez Hootonie Begay, male, age, 45

John Nez Hootonie Begay's child; female, age, 34.
John Nez Hootonie Begay, male, age, 30 Wife survived
John Nez Hootonie Begay's nephew; male; age, 18.
Dura Clizhen; male; age, 35. Four children, ages, 15, 12, 10 and 5 years Wife survived.
Dura Clizhen's brother, male; age, 25 One child Wife survived
Nokai Denas; four children.
Hosteen So Bitse, female; age, 4
Dayteen Bitsoie's boy, age, 18
Dayteen Bitsoie's girl, age, 9
Dayteen Bitsoie's boy, age, 8.
Dayteen Bitsoie's child, age, 6 months
Eshin Sosie Bitse, female, age, 6 months
Dogi Yazzie, male, age, 20.
Dogi Yazzie's wife
Dogi Yazzie's child, age, 18 months
Dogi Bitdaizy, female, age, 30
Dogi Bitdaizy's husband
Dogi Bitdaizy's child, age, 7
Dogi Bitdaizy's child, age, 5
Dogi Bitdaizy's child, age, 3.
John Nez Hoolonie Benullie; age, unknown
Belin Cizhin Beti Bitse, female, age, 10
Hosteen Yazzie Bitsilly's child, age, unknown
Smilie Bidoney's granddaughter
Tom Holliday's son, age, 22.
Tom Holliday's second wife, age, 55
Hosteen Chee Bitsee
Jah Nez Holoeice Begay
Jah Nez Holoeice Begay, relative
Crank's son, male, age, 21
Smilie Bidonny, male, age, 50
Maud, a school girl, age, 16

Five Piutes were also found dead on the trail between here and the San Juan river I had them buried by the two Mormon men who discovered them.

Some Suggestions on Climate.

ALBERT B REAGAN

In August, 1913, while I was Indian agent at Nett Lake, Minn., I visited my mother at Fredonia, Kan, and found the whole country burning up with drouth and scorching sun At the same time the newspapers at Duluth, Minn., were printing headlines, "Its Cool at Duluth." Moreover, in northern Minnesota it was raining nearly every day. Last winter (1917-'18) the eastern part of the United States to some distance west of the Mississippi river was snowed under and experienced the worst winter in years, while at the same time the western United States, the Rocky Mountains and the plains had scarcely any winter, the lightest in many years. This winter (1918-'19) the Rocky Mountains and the plains have the severest winter in years and the East hardly any winter at all. Congressman C. B. Miller writes me that Minnesota has a "banana" winter, it is so warm.

It would seem that wherever the cold wave first strikes in the early winter sufficiently to cause a heavy blanket of snow to fall, a cold area is there generated, and as cold, like anything else, tends to perpetuate itself, the accumulation of cold and consequent snow continues in that area till the re-

turn of the spring and summer sun effaces it. Furthermore, the rushing of the colder air to this region leaves the warmer air to occupy the other adjacent regions. In summer it would seem that the excessive heating of certain areas acts in a similar manner. It would also seem that cloudy weather, contrary to the general belief, perpetuates cold, at least in mountain regions. For instance, in clear years it is not cold in the Navajo country. This winter, a very cloudy one, the mercury has gone as low as 35 degrees below zero. Also in the cloudy, rainy Olympic country of Washington there are extensive glaciers, though the mountains, even in highest points, do not exceed 8,000 feet in elevation; while mountains in the drier regions of Washington, Idaho and Montana in the same latitude, though of practically the same elevation, possess no glacier fields. It appears that if there was no more precipitation in western Washington than there is in, say, Arizona, the glaciers of the Olympic mountains would not exist

The writer hopes that others who have better facilities for observation will look further into this subject.

Scientific Measurement of the Achievements of Pupils.

F J KELLY, Dean School of Education, University of Kansas

Advancement of any science depends primarily upon the accuracy with which the materials entering into that science can be measured. Until education can measure its products more accurately than it yet does, the claim that education is a science will not be generally allowed. It is the purpose of this paper to indicate some of the steps which have been taken to make possible a more accurate measurement of pupils' achievements.

Before telling of these recent efforts in deriving more accurate measures we must set forth quantitatively the extent of inaccuracy which prevails in our ordinary measures of educational products We are constantly measuring the results of instruction. Examinations have been a part of school procedures ever since schools existed. On the basis of these examinations honors are awarded, pupils are encouraged to think that they are brilliant, or discouraged to think that they are stupid. Civil-service positions are awarded; teachers are granted certificates to teach; in fact, very much of our social structure rests upon examinations, which are the present-day measures of achievement. How reliable or unreliable these measures are is not generally known among people, even those engaged in educational work. There is just a sort of vague feeling that they are not a very satisfactory means of determining achievement

The three most typical studies revealing the extent of the reliability of the examination paper as a measure are (1) that of F. Y Edgeworth, professor of political economy in the University of Oxford; (2) those of Starch and Elliott, of the University of Wisconsin; and (3) that of the writer. Professor Edgeworth raised the question of the validity of the civil-service examinations in England, and in order to measure the reliability of the ratings upon the civil-service examination papers he sent facsimile reproductions of one of the examination papers to a group of twenty-eight head masters of the schools from whom examiners were chosen. Any one of the twenty-eight head masters was admitted by the civil-service commission to be competent to rate

the paper, and might have been chosen as the one to rate the papers used by the commission in selecting civil-service candidates. These twenty-eight examiners marked this paper from 45 to 100, seven of them marking it 72.5 or below and seven others marking it 85 or above. With this as a beginning, Professor Edgeworth made a very extended study of civil-service examinations, and gave as his conclusion the following: "I find the element of chance in these public examinations to be such that only a fraction, from one-third to two-thirds, of the successful candidates can be regarded as quite safe—above the danger of coming out unsuccessful if a different set of equally competent judges had happened to be appointed."

Starch and Elliott, in the University of Wisconsin, sent out facsimile reproductions of an English examination paper and of a geometry examination paper to the heads of English and mathematics departments, respectively, of the high schools of the North Central Association of Colleges and Secondary Schools. These schools represent the highest type of schools in the whole upper Mississippi valley and these department heads are persons who have been long in the service and have had a chance to discover the standards which prevail in examination papers in their departments The English paper was rated by 142 English teachers and the geometry paper was rated by 116 mathematics teachers. Of these 142 English teachers 91 were in schools where 75 was the pass mark, and the median mark given by these teachers was 88.3, with a median deviation of 4.5 points. The other 51 teachers were in schools using 70 as a pass mark, and they gave a median mark of 87.2, with a median deviation of 4.2 points The 116 mathematics teachers gave to the geometry paper a median mark of 70, with a median deviation of 7.5 points. Some of the teachers marked the English paper below 65, while a goodly proportion of them marked it above 90; 37 of the 116 mathematics teachers marked the geometry paper below 65, while 9 of them marked it above 85 This means that in the case of the English paper there is one chance in four that the mark would be changed by as much as 8.3 points when taken from the head of one English department to the head of another English department in these North Central Association schools, whereas there is one chance in four that the geometry paper would be changed by 15 points if it were taken from the head of one mathematics department to the head of another mathematics department for rating.

Such data as the foregoing are accumulating very rapidly. The writer undertook a few years ago to gather much more extensive data upon the subject of the extent of disagreement in values assigned to examination papers by two presumably competent judges. New York state has had a system of regents' examinations for more than thirty years. These examinations have been used during all this time as the basis for promotion in all the accredited high schools of the state. They were formerly given annually, and have for many years past been given semiannually under the direction of the teachers of the high schools, and the papers have been rated first by the teachers and then by the group of examiners employed by the regents. Because of the long standing of this system it appears that if persons can come to an agreement as to the value of an examination paper, such agreement should have been reached in New York state. In 1914 I studied the markings given, first by teachers and second by the regents' examiners, to all the regents' examination papers written in the high schools of New York in the year 1912.

This gave a total of 392,352 papers. Of these papers 18.5 per cent were marked failed by the teachers. When the papers which were marked passed by the teachers were sent in to the regents an additional 15.7 per cent of these were marked failed by the regents' examiners. It will appear from this, in the first place, that the disagreement between the teachers and the regents as to what constitutes a passing paper is very marked. In some of the subjects the percentage failed by the regents of those passed by teachers was much higher than 15.7 per cent. For example, of all the mathematics papers, 25.7 per cent of those passed by the teachers were marked failed by the regents. In commercial subjects 20.9 per cent of those passed by teachers were failed by the regents. The distribution of the teachers' ratings upon those papers which the regents subsequently marked failed is even more illuminating. Although the passed mark used by teachers and regents is 60 in New York state, 6.4 per cent of all the papers which the regents subsequently failed were marked 79 or better by the teachers.

Turning now to those papers which both the teachers and the regents allowed to pass, it is interesting to note the range of difference between the mark given a paper by the teacher and the mark given the same paper by the regents. Of all the papers marked 75 by the teachers only 7.48 per cent were given the same mark by the regents; 25 per cent of the papers marked 75 by the teacher were increased one point or more by the regents; 25 per cent were decreased seven points or less. It appears, therefore, that there is one chance in four that a paper marked 75 by the teacher will be marked as low as 68 or lower by the regents. When this is considered in connection with the rather narrow range in which marks lie (less than 25 per cent of the marks being above 74 on all the papers), the significance of this disagreement becomes apparent.

No more details of this study need be given in such a paper as this. If physicians had no better means to determine temperature and measure results of their prescriptions than we are using in education to measure the results of our practices, we would hesitate to call medicine a science. If pharmacists could not agree better on the measures of their drugs, if engineers could not agree better on the measures of their electric currents, we would cease to have much confidence in the science of pharmacy or in the science of engineering. It is because of its bearing upon this very fundamental problem that I am keenly interested in the development of more scientific measures of educational products.

In the more progressive educational circles more accurate measures in certain school subjects are now available. In the fundamentals in arithmetic, for example, the Courtis tests are used very widely to measure the degree of skill which children possess in the abilities of addition, subtraction, multiplication and division.

By means of these tests, given and scored according to directions, it is possible to determine the relative standing of individual children or groups of children in these fundamentals. As a matter of fact, these tests have been given sufficiently widely so that it is possible to compare the achievements of children in cities of the first class with children in cities of the second class and cities of the third class and in rural schools in these important fundamental operations. It is also possible to measure the increase in achievement

which children make in these fundamentals under the instruction of a given teacher, and thus measure the teacher's efficiency in this line with almost entire accuracy.

In the same fashion progressive schools now define achievement in penmanship according to the comparison of the child's writing with certain samples whose excellence has been determined by a large number of competent judges. Thus when a child is able to write so as to achieve a mark of 50 by the Kansas City scale and another child is able to write so as to achieve a mark of 60 by the same scale, we are reasonably certain that the second child writes about as much better than the first child as sample 60 is better than sample 50 on the scale. We can by means of the scale measure the improvement of children's writing under certain methods of teaching penmanship. We can measure the success of the teacher by determining how much progress her children make in penmanship under her instruction. We know from wide use of the scale how much progress children on the average make in each grade, and we can compare the achievement of a given teacher with average achievement of teachers in a like grade

There are also tests which may be applied to measure efficiency in oral reading and efficiency in silent reading In the former the score will indicate whether the reader is poor in pronunciation, poor in expression or poor in his knowledge of words. In silent reading separate measures are taken of the understanding of the printed paragraph and of the speed with which a child reads. All of these tests are so devised that there is little or no difference in rating by several judges of the same examination paper. When we find, as we have found, for example, that Iowa children, on the whole, read better than Kansas children to an average extent of 10 per cent of the number of words per minute which can be read with complete understanding, it is a significant discovery, and it has been used as a basis for the demand that Kansas children be allowed to have in their public-school work more than one reader per year. By being able to make all of these comparisons, from child to child or group to group, we are able to measure the efficiency of certain practices in elementary education.

I do not assume that you are interested in the details of these tests and scales now being devised. You are interested in the effort being made by men in education to derive such standard definitions of achievement as will enable us to build a science to replace the guesswork of former days. Suffice it to say that practically all leading cities in the country are now employing directors of educational tests, whose business it is to interpret the materials and methods employed by the teachers in terms of these more scientific definitions of achievement.

The tests which I have mentioned refer only to the tool subjects, supposed to be mastered in the elementary school. When it comes to information subjects, such as relate to vocational courses, or even to a good deal of the work in the academic departments of high school and college, the development has been even more slow. It is certainly true, however, that definitions of units in both high school and college must be clarified before we can hope for recognition.

Studies of Insects Associated with the American Mistletoe.

ELBERT S. TUCKER

INTRODUCTION.

By the name "American mistletoe" the species *Phoradendron flavescens* Nuttall is meant, and of this peculiar aboreal shrub several varieties are described by botanists. The plant thrives most exuberantly throughout the South and the Pacific coast region of the United States. On account of its near relationship to the renowned European mistletoe or "Wood of the Holy Cross," *Viscum album* L., the American countertype has inherited the popular traditional attributes of that symbol of veneration. Its use for festival adornments at Christmastide has consequently earned for it the standing of a marketable product during this season of celebration.

But little repute is now accorded it for medicinal virtues While it is not considered to possess any special merit for healing properties, yet in winter when succulent herbs are scarce or lacking it affords a substitution which country folks often resort to, and thus utilize the shoots in order to make a vegetable lotion for the remedial treatment of scalds or wounds. The desired extract is prepared by boiling the leaves and stems together in water. In its green state it is also esteemed as a food tonic for live stock, especially cows and mares directly after one or the other has given birth, as the case may be, either to a calf or a colt. Such usages, however, are not thought to be in common vogue outside of certain sectional bounds.

Owing to its parasitic nature in growing upon live timber, it has come to be regarded in some localities of Texas, Louisiana, Mississippi and Tennessee as a serious detriment to the perfection and vitality of shade trees in particular. The results of investigations of its injuries to such growth, embracing an account of its life history and the practical methods for its suppression, have been published under the title of "The Mistletoe Pest in the Southwest," by Prof. W. L. Bray.[1]

Not much contemplation has heretofore been devoted to the insects which normally inhabit or otherwise visit any of the various mistletoes. Of most importance in respect to the advances that have been achieved in this direction, aside from the incidental contributions by Prof. T. D. A Cockerell in dealing with the Coccidæ, is the pertinent treatise by Mr. E. A. Schwarz.[2] The study of mistletoe insects is not only interesting for the sake of the romantic fame of the floral stock itself, but it offers unquestionable possibilities for new scientific revelations. Even though the pursuit has from time to time in the past led to the detection of valid species of Hexapoda which had formerly been unknown, the range of endeavor is by no means fully covered. Taking the substance of the present report into consideration, the progress so far attained in the quest has reached the point where it now tenders a basic list of the attendant fauna and a fair knowledge of the habits of the latter in conjunction. That the American mistletoe should be invested with a singular but yet potent aptitude as a host plant from an entomological standpoint first

1. U. S. Dept. Agric., Bu. Plant Ind., Bul. 166; 1910.
2. See Bibliography for each author.

came to the writer's notice by accident. This matter primarily appertained to a rare weevil concerning which the following details of inquiry have been recorded.

THE WINTER MISTLETOE WEEVIL.

(*Smicraulax tuberculatus* Pierce.)

While making a short trip into the country near Plano, Tex., on December 12, 1908, the writer took advantage of an opportunity to obtain some mistletoe for Christmas decorations. Accordingly, after collecting several bunches of *Phoradendron flavescens* from hackberry trees, the pick of them was carried to Dallas and hung around the rooms of the house then occupied as living quarters. About ten days later, on being seated at dinner, attention happened to be drawn to a small weevil crawling on the tablecloth. Its strange presence excited surprise, and it was therefore immediately captured for closer scrutiny. Within a few more days the appearance of a tiny winged wasp in a similar manner again caused wonderment as to the source of this suspectedly hostile interloper, and correspondingly revived the problem bearing on the obtrusion of the former visitant. In pondering over the circumstances in search of a clue, the idea was suddenly conceived that both of the bodies had dropped down from some sprigs of mistletoe which festooned an electric chandelier, this fixture being suspended from the ceiling right above the table.

Suspicion was thus directed to the plants as having harbored these guests. At this time the branches had become much dried and shriveled, and, moreover, since Christmas day had passed for the year, they conferred no further commemorative attraction. All of them were promptly removed and placed in a breeding box belonging in an outdoor insectary. They forthwith furnished proof of infestation by producing different parasitic imagoes at intervals during the subsequent month of January, 1909, although no additional weevil emerged.

By reason of its odd figure and intimation of having bred in the mistletoe, the weevil already in hand was expeditiously forwarded to Mr. W. D. Pierce, in Washington, D. C., for identification. He reported that it was the second cognitive example of his genus and species, *Smicraulax tuberculatus,* just previously defined in his paper, "Descriptions of New Curculionid Beetles of the Tribe Anthonomini."[3] Nothing more then chanced to be learned about it than that "the type specimen was collected by Mr. E. A. Schwarz on black persimmon," at San Diego, Tex. Mr. Pierce urged that observations regarding it be followed up.

In the acquisition of parasites the first subject, which was caught by luck, agreed with authentically named representatives of *Catolaccus incertus* Ashm. Likewise, by comparison, the others appearing in January proved to be a female *Cerambycobius cyaniceps* Ashm., a male and a female *Eurytoma tylodermatis* Ashm., and a male *Bracon mellitor* Say. Furthermore, two dead males of *Catolaccus hunteri* Cwfd. were taken on March 12 at the final inspection of the material. Since all of these agents were known to attack the immature stages of the cotton boll weevil, *Anthonomus grandis* Boh., their possible connection with *Smicraulax tuberculatus* Pierce introduced an astonishing exigent phase, in which the latter seemed to fill a very important position as winter cohost for the parasites.

3. Proc. U. S. Nat. Mus., vol. 34, 1908, pp. 173, 174.

Such relations in fact were shortly established by conclusive evidence. Their disclosure consequently extended the scope of an investigation then being centered upon the parasitical control of the boll weevil. Previous to this discovery not very many native Rhynchophora which foster the parasites that also prey upon the boll weevil had been found to breed with any degree of activity through winter. In the present case the hiemal concurrence of the development of *Smicraulax tuberculatus* with the vigorous growing and fruiting term of the host plant placed the tenant in the rather unique rôle of an intermediary capable of sustaining several kinds of parasites through a crucial period of the year. Under other conditions generally prevailing these salvagers instinctively enter into hibernation on the approach of cold weather and pass the winter in torpid inanimation. Moreover, as *Smicraulax tuberculatus* is structurally allied to the cotton pest, it should be expected quite naturally to attract parasites that evince a preference for members of the tribe Anthonomini.

During another trip to Plano, on February 12, 1909, a second supply of *Phoradendron flavescens* was secured from like trees in the same vicinity where the first collection had been made in the preceding December. These branches uniformly answered to the varietal name of *villosum* Eng., this discrimination being ascertained next day by reference to botanical literature. Then, on slitting open some of the joints, a number of diminutive larvæ exhibiting all the characteristics of a weevil grub were exposed to view, mainly within the terminal stems. They were concordantly judged to be the young of the eagerly sought weevil. With the removal of eight subjects for preservation, three dead ones were included. The mortality among them was believed to have been due to a hard freeze brought on by a recent spell of low temperatures.

Most of the infested sprigs had an unhealthy look On one branch all the leaves had turned brown No swelling, however, appeared on any part that had suffered impairment. These stems seldom measured less than 2 mm in diameter, but occasionally the work of a grub was noted in twigs nearly 5 mm. thick. At divers places on the bark a slight nick showed where an incision had obviously been effected, either for oviposition or food alone. From the majority of these dints a thin discolored streak was traced diagonally into the heart of the stem. Here a single larva was commonly descried inside of a gallery or cell. In many instances the separate burrows ran almost through the entire length of a scanty joint, but ordinarily they were much shorter, sometimes being nothing more than a mere hollow space. Where an exit hole had been cut out from a tunnel, the perforation usually opened on or was close to a nodular dilation.

The body color of the larvæ was perceived to impart a faint yellowish tint to the skin, but the pallor set off the brown head shield and black mouth parts in strong contrast. Those selections of the progeny that seemed to be full grown had a linear extension of about 2 mm. One male chalcidoid, so far remaining undetermined, issued on March 24 from the shoots which were held in reserve, but no complemental realization attended this breeding test.

Mr. Pierce himself joined the writer on an excursion for the third lot of mistletoe. These plants were picked from oak trees, *Quercus schneckii* Britt.,

near Dallas, Tex., on March 6. This stock yielded the positive results which fully confirmed our assumptions regarding the generative activities and influential sphere of *Smicraulax tuberculatus,* and besides pointed out the association of another weevil, *Pandeleteius cinereus* Horn. Notes on the latter species and also the other kinds of insects that were collected in the prosecution of this and the succeeding explorations, taking the enemies as acquired with their hosts, are presented farther ahead in systematic order.

Needless to say almost, the substantial returns as derived from this accession were very gratifying. Those features that applied to the main proposition now in hand were brought out by the following ascertainments. A teneral adult of *Smicraulax tuberculatus,* the first exemplar of its sort that happened to be espied *in situ,* was abstracted from its tiny den in a twig and saved for later mounting. The betraying scars on the surface of the woody growth as well as the inner cavities were more frequently located at intermediate distances along the stems than near their junctures. Many of the excavations had already been vacated, yet the freshly bored outlets denoted that the originative inmates had but lately gained their freedom. Nevertheless, a proportion of the brood lingered behind. One joint alone still retained not only a larva, but also a pupa. Though a solid partition had separated them, both were parasitized alike. This proximity of the two stages comprised the sole exception wherein more than a single form of the weevil were found to occupy an identical section of any offshoot. The sickly yellow tinge of this piece testified to the severity of the internal depredations.

Although the tentative diagnosis was limited to just a few sample branches, this appraisement, however, took twenty-two exemplifications of the weevil into account. The conditional findings in these respects are summarized herewith:

Stages alive, unaffected	6 = 5 larvæ and 1 teneral adult
Stages alive, parasitized	8 = 7 larvæ and 1 pupa.
Stages dead, due to parasites	2 = 2 larvæ (1 with grub and 1 with pupa of *Catolaccus sp.*)
Stages dead, charged to cold	6 = 6 larvæ.

For parasitism the inhibitive rating was 45.4 per cent, for fatality attributed to cold, 27.3 per cent. These factors, therefore, gave a total mortality of 72.7 per cent, prospectively involving the doom of the eight forms still withstanding the grasps of their deadly foes.

Four of the inimical dependents matured in isolation, producing a male and a female chalcidoid on March 30 and likewise another pair on April 3. Their specific identities have not yet been conclusively determined, but a couple of them were justifiably referred to the genus *Catolaccus* on the strength of their formative distinctions. From the bulk of the sprigs that had been kept under watch two collateral members of the same class perfected their emergencies on April 2, and again five others, consisting of three males and two females, were secured on April 6. The cages also contained three adult weevils on the latter date, and solitary individuals were afterwards entrapped on April 19 and 29, and lastly on May 3.

Even with these few specimens, the outcome was especially appreciated for the reason that it gave tangible results, notwithstanding the handicaps which attended the test. The drying and shriveling of the branches shortly after they had been stored away, despite their placement on a bed of moist sand,

plainly imposed a check upon the progress of the indwelling forms to a large extent, and thus curtailed their ultimate attainments.

At the next trial an attempt was made to overcome the latter difficulty by inclosing the fresh plants in a tight receptacle that conserved the moisture, but this procedure soon had to be abandoned owing to the formation of mold on the stems and leaves. This new supply of shoots was gathered on April 7 from the same oak trees as before. Two live weevils, the only free ones ever bagged on a visit to the field in person, were, by good fortune, sifted out from the mass of twigs and litter prior to the transference of the suitable portions into the repository.

As in the other cases, a part of the material was first sectioned in order to ascertain if the degree of infection would warrant the consignment of the greater quantity. On arriving at a favorable decision to this effect, the remaining stock was then utilized for the experiment. At its termination these pieces were also slit into bits and carefully inspected. In consequence the dissections at the start, together with those at the finish, brought to light four extra imagoes reposing in as many joints. Two of these examples, however, failed to manifest any animation, yet, queerly enough, one was lodged headforemost within the orifice at the outer end of its passage that had been made ready for its egress. The cause of its death on the verge of release could not be solved. Of the thirteen larvæ which were scatteringly located all proved to be dead, although only two of them had been assailed by parasites.

Quite a number of empty chambers were laid open in the same manner, and these decisively attested to an early liberation of adults in nature. Owing to the fact that nearly every mine had been driven full against or even into a junctional knob, this phase set them off at a variance with the precedent definements in regard to construction. Escape therefrom was necessarily achieved through a transverse penetration leading from the main recess to the exterior, thereby forming the outlet which has been alluded to before. As might be presumed, this aperature was drilled to the circumferential size of a mature weevil, and as well marked the region of the destructive operations of the insect when in the larval stage. In reality the two borings usually conjoined at a point close to the terminal limits of the inner one, and thus abutted upon a node in nearly equal juxtaposition.

The late punctures in the bark were found to have been inflicted rather indiscriminately on diverse sides of the stems. Altogether sixty-four resultant scars were counted, each flaw being barely distinguished by its indenture. Still, on parting their tissues, no egg could be discerned in any of the lesions. Those pits in which the deposition of ova and the sequential hatching of the latter had been consummated beyond all question of doubt were readily differentiated from the others whose perpetrations implicated no further design than that of feeding by the parent weevils. As a matter of fact, the distinctive sign of embryonic culmination consisted of a morbid discolorment of the woody fibers beneath the cleft in the integument wherever the event had taken place. From this blotch a tenuous stain receded slantwise in a longitudinal prolongation through the grain until it reached the heart. Here it often connected with a larval breach. Such tracings clearly demarcated the course which a newly hatched grub had pursued in forcing a way for itself from its birthplace into the core of the stem.

The next advisable step for carrying on the project was to acquire information relative to the distribution of *Smicraulax tuberculatus.* This desideratum accordingly became an incentive for a broad survey. Some cursory scouting had already been done in two localities along the lower Red river in Louisiana, first by the writer while on a trip to Alexandria during February 27, and thence to Mansura on March 2 (of the same year, 1909). The outcome of these visits in person, however, fell short of rendering any positive interpretation, because of the failure to find a weevil or definite sign of one. Even with the closest scrutation, nothing was seen to occasion much concern except in respect to the plants at Alexandria. On the bark of their branches a few slight notches chanced to be perceived whose semblance to shrunken punctures was strongly suggestive of mischief. If these defects conveyed any entomological significance, such could only be surmised with reference to *Pandeleteius* sp, the larvæ of which were taken from mistletoe at Mansura by Mr. W. D. Pierce hardly more than six weeks later, or on April 13, when he fulfilled an engagement there himself. His record is the only one so far obtained which authenticates the existence of any mistletoe weevil in the state of Louisiana, and the full particulars are cited in their proper place among the various notes on *Pandeleteius cinereus.*

Yet on April 10, during a stop at Natchez, Miss., Mr Pierce had found larvæ which he thought belonged to his new species But owing to other demands, his examination was limited to just a few sprigs of mistletoe that had grown on live oak. He also reported that a young chalcidoid parasite was attached to one of the grubs. The writer's subsequent assignment on official duty near the same city allowed opportunities for making some personal observations on the occurrence of the insect in that locality.

At the start of operations, on May 22, an ample quantity of *Phoradendron flavescens* was detached from an elm tree Assurances of a late intrenchment by *Smicraulax tuberculatus* were warranted at once upon sight of its ovipositional imprints and channels of escape, these being displayed in profusion. Hence by disseverment of the stems plenty of cells were scanned within them. Since they mainly lacked occupants, no live stages were run onto, although eight larval bodies happened to be uncovered, three of which had succumbed to parasitism. The deaths of the remainder had likely been induced by the heat of summer and the reparative tendencies of the plant itself, as was inferred after studying the supplemental acquisitions. Attempts to rear the parasites failed absolutely, and neither did the supervening trials that were instituted in like cases avail to any purpose.

While the branches showed that they had been highly infested earlier in the season, yet at this time they gave no proof of any propagative continuity on the part of the marauder. The same conditions applied to all of the inspections of mistletoe that were undertaken up to their close on June 2. Such circumstances supported the belief that the ascendence of warm temperatures conduced to bring about a suspension of breeding. This opinion was eventually corroborated by inquiries conducted at Dallas again and elsewhere in Texas until along in 1911. Nevertheless, further investigations are required in order to solve the question as to how the weevil survives from spring to fall, and whether it actually resumes the exercise of its reproductive unctions much before December.

The liklihood that it ranges to the east side of the Mississippi river, however, was duly conceded, though this claim needs to be fully substantiated. This admission, moreover, predicates an adaptability of the insect to live wherever its host plant exists.

Another matter of interest that commanded a due share of attention at this time and henceforth related to the manner in which the plants had endeavored to heal up their wounds. Hitherto very little indication of such an aptitude had been revealed, whereas, more especially in the collections at Natchez, Miss., than any of the later ones, a great number of the damaged stems had made marked advances toward recovery. With the object of gaining a fundamental conception of these phases, each lot of mistletoe was promptly examined with particular care As a result the following adductions were gleaned

In regard to the areas wherein the borer had operated, most of them were observed to be filled with a resinous gum. The consistency of this product, however, varied from a semiviscid state to one of hard density. Its solidification was obviously attained through age. In every case it was distinguished by its brownish translucence. Owing to its permeation into the surrounding grain, the latter had acquired a concolorous tinge. This substance had therefore practically obliterated the ill effects of the inroads in those places that seemed to have had sufficient time wherewith to accomplish their recuperation.

Since the restorative process through such means was conceived to be analogous to proliferation, the risk of its crushing force upon a feeble attacking larva impressed the mind as being an important factor. In reality, not only at Natchez but in the concluding surveys as well, dead grubs were occasionally found embedded in the deposits. On account of the plastic condition of the content in each of these instances, it then appeared to be but newly secreted The mummified bodies were always of small size, because the forms had made very little headway in life when foiled. Consequently, no better reason can be given in explanation of their lethality than that the young creatures were overcome by the pressure of the accretions which had first engulfed them. On the other hand, many individuals had apparently been able to forge ahead in spite of these complications, having doubtlessly succeeded in firmly establishing themselves at the outset.

The occlusion of the exit holes was also noted. Such repairments were effected by an outgrowth of the cambium layer over the raw edges, as would naturally be expected In a number of cases those parts of the sprigs that had undergone the worst inflictions showed a noticeable distention of the sides, the outlines of which conformed to a bulge of more or less linear convergence. These swellings accordingly afforded evidence of a rapid enlargement of the growth for reinforcement of the weakened structure. Otherwise, except for the persistent rays resulting from the entrance of larvæ, the enveloping wood had regained a sound and healthy look.

Henceforth the reconnoissances were continued as opportunity permitted, the prime object being to learn more about *Smicraulax tuberculatus* and its parasites. This intention was also coupled with a proposal to ascertain incidently if the excessive droughts and extremes of summer and winter temperatures that were experienced in Texas during the years of 1909 and 1910, and which exerted a marked constraint upon insect life in general throughout the

state, had reacted in any such manner upon the mistletoe raiders. The ultimate conclusions that these years had proven unfavorable by bringing about both a curtailment in the ranks of the weevils and an absence of their kindred enemies were educed from the following memoranda.

At Dallas, Tex, on December 19, 1910, some branches of mistletoe were found to be rather commonly, but by no means extensively, attacked; still on the other hand, a large amount of the plants had not been molested at all. The former had thereby incurred quite a complex of bores. Those of old or recent assuagement, however, outnumbered the fresh comminutals. As a rule, the thin stems had suffered most from the onsets No parasitized larva was taken, and nothing besides two adults of *Smicraulax tuberculatus* issued from the joints. These specimens made their appearance along in February, 1911. Yet in the initial examination a dead imago had been extracted from a cavity wherein it was lying with its head directed forward at the point of egress, thus occupying about the same position as has been mentioned once before. Three additional collections of *Phoradendron flavescens,* these being obtained at weekly intervals during the subsequent month of March, gave utterly negative returns respecting the weevil.

Just enough evidence was secured at Sherman, Tex., on January 10, 1911, to vouch for the scarcity of the species in that locality. Although the operative members had already matured and escaped, leaving their empty burrows and fresh emergence holes in partial attestation, still unquestionable proof of their identity was presented in one cell which contained a pupal exuvia together with the larval headplate, while another space held an entire dead grub. A few scars on the bark and the accompanying stains within the joints completed the chain of incriminations to be preferred against the insect. The fact that very little mistletoe was seen growing in the country provoked some perplexity.

The signs of greatest activity by *Smicraulax tuberculatus* came to notice after the approach of settled spring weather. They occurred on two bunches of mistletoe which were hastily snatched from a hackberry tree near Mesquite, Tex., on April 27, but a dead larva comprised the only stage that remained in the shoots. Since further search was prevented owing to the limitation of time then devoted to a special mission, these branches may not have tendered a true indication of general prevalence by the adversary This record constituted the last of the series.

Besides *Smicraulax tuberculatus,* two other species of weevils are known to breed in the live stems of *Phoradendron flavescens.* Neither one, therefore, can properly be given a common name linked with that of the host plant alone, although so far as has been learned about them, the former is thought to be preëminently *the* American mistletoe weevil. If the writer's opinion holds good with regard to its breeding only during cool or moderately cold weather, it might well be called the "winter mistletoe weevil." Nevertheless, *Pandeleteius cinereus,* at least, stands close in conflict with this appellation.

THE GRAY MISTLETOE WEEVIL,

(*Pandeleteius cinereus* Horn.)

As stated in the foregoing disquisition, the discovery that *Pandeleteius cinereus* Horn also bred in mistletoe stems was brought out in the course of examining a quantity of *Phoradendron flavescens* collected by the writer in

company with Mr. W. D. Pierce, near Dallas, Tex., on March 6, 1909. By reason of the fact that we captured the adult on the branches at the time they were obtained, and furthermore swept a stray specimen from a juniper tree standing not far from the same spot, our interest was inductively aroused by suspecting the propensity of the weevil as to its food habits right away. In accord with this inclination, the actual proof of the breeding of the insect in mistletoe eventually fulfilled our expectations. Mr. Pierce is responsible for the determination of the species

Its larvæ were met with only in the thickened parts of the growth, none of which measured much less than 5 mm in diameter. At first two subjects were removed alive, but the third made no responsive movement. Their separate trails showed that each individual had started within a node and excavated along through the center of a joint towards its opposite extremity, yet in only one instance did the burrow reach to the next juncture, a distance of one and one-half inches The rear area of every tunnel was stuffed with frass. Because of the paucity of the grubs, most of the stock was reserved for rearing purposes in order to ascertain if *Pandeleteius cinereus* would really mature from them, and thus establish the identity of the young form for a surety.

On April 6 three dead imagoes were found in the breeding box which contained the material. No parasites can be recorded as attacking this weevil, still all developmental tests were conducted in connection with *Smicraulax tuberculatus*. Since a large proportion of the different foes which bred out from the sprigs under such circumstances agreed with isolated rearings of the kinds preying on the chief invader, very little probability remains that any of them came from another host. At least, no parasitized stage of *Pandeleteius cinereus* has yet been taken.

After being able to recognize the work of this ally, exact signs of it happened to be noticed in an odd joint among the plants that had been brought from Plano, Tex., on February 12. The next record of its occurrence chanced to be the one in which Mr. Pierce reported his finding of two larvæ in stout pieces of mistletoe that were detached from live oak at Mansura, La., on April 13. Judging by the large amount of material which he inspected, and the contrary results of the writer's own examinations preceding him at the same place and in addition at Alexandria, the insect seemed to be somewhat of a rarity in that region. Mr Pierce has, therefore, supplied the only definite information concerning the existence of any mistletoe weevil in the state of Louisiana. He also secured a number of other interesting insects and various sorts of injuries, all of which will be accounted separately.

From the supply of mistletoe acquired on December 19, 1910, at Dallas, Tex., more examples of the early stage were procured. The main characteristics as noted regarding them will serve to differentiate the larva of *Pandeleteius cinereus* from that of *Smicraulax tuberculatus*. In comparison, the former considerably exceeds the latter in size, and it naturally constructs a larger and longer gallery, always in a plump axis. Its body is entirely pure whitish, even including the head, with the exception of the jaws alone, which are black. As the grub progresses in the formation of its channel it fills the space behind itself with refuse matter.

An attempt to rear one of these forms through artificial introduction into a perfect branch merely demonstrated the possibility of success. On drilling

a hole of sufficient play for a short distance lengthwise into the base of an ample section, the tender creature was gently inserted therein with its head foremost. Wet cotton was then wrapped over the opening. The subsequent drying of the wood, however, in spite of its being partly imbedded in moist sand, necessitated almost regular weekly changes of the inmate to fresh growth, but such strict attention could not be carried out continuously.

The ideal way for the thorough study of the development of insects which subsist particularly within the tough portions of such vegetation evidently demands that they be bred or reared on live plants under natural conditions as near as possible. By the selection of suitable offshoots growing on a tree that will permit convenient accessibility for purposes of frequent close observation, the life histories of the weevils or other borers which are prone to adapt themselves thereto could probably be worked out in complete detail. The feasibility of this scheme is expected to depend much upon a skillful insertion of immature specimens into stems, so as to effect their transferences from originally infested branches of different lots. Hope is entertained that the successful replacement of any one after exposing it for inspection may also be accomplished by these means.

Such practices, if dependable, should overcome the paramount difficulties attending the study of developmental stages living within green woody tissues. With the aid of cloth bags to be used for inclosing the sprigs when chosen for breeding experiments, thus affording a necessary protection of the operations between times of examinations and also guarding against the escape of mature colonists, all the advantages of a natural nursery would seem to be placed at the command of an investigator. Although the prospect appealed very strongly, the press of routine duties otherwise prevented the prosecution of the undertaking.

In proposing a vernacular name for *Pandeleteius cinereus*, it may quite fittingly be termed the "gray mistletoe weevil." The species might have other host plants, as it has been taken quite often at random, but so far as known only in territory where mistletoe flourishes.

OTHER COLEOPTERA.

Otidocephalus arizonicus Schf. Det. by W. D. Pierce.

The finding of a lifeless but still fresh adult of this weevil, on April 22, 1911, excited some astonishment, as it was the only outcome of much consequence from a breeding test conducted by the writer with mistletoe branches that had been gathered on March 18 preceding, at Dallas, Tex. Mr. J. D. Mitchell obtained larvæ from twigs which he collected on March 16 at Victoria, Tex. He succeeded in rearing two specimens. One emerged and the other was found dead in a stem on May 28, and then a pupa happened to be secured besides. Three parasites representing the species *Sigalphus curculionis* Fitch matured from the breeding material on April 2. These records are not only new for Texas, but the occurrence of the weevil at Dallas and Victoria shows a remarkable range of the insect which had hitherto been regarded as being peculiar to the arid regions, as in Arizona, where, in fact, the species was discovered by Mr. E. A. Schwarz. (See Bibliography.) As a titular denomination that of the "southwestern mistletoe weevil" may properly be applied to it.

Compsus auricephalus Say.

A single representative weevil was captured by Mr. Mitchell at Victoria, Tex., on March 8, 1909. It was doubtlessly adventitious on mistletoe, since the insect normally breeds in roots of weeds. Record is cited by Mitchell and Pierce. (See Bibliography.)

Sibinia (Microtychius) inermis Casey. Det. by W. D. Pierce.

Adults were collected as in the preceding case. While Mr. Mitchell took several individuals of this weevil on *Phoradendron flavescens*, he could not detect any signs of their breeding thereon. All were probably incidental visitors.

Smicronyx spurcus? Casey.

One weevil simply marked "Mistletoe," the parts being recalled as dead stems, was submitted by J. D. Mitchell, of Victoria, Tex., under date of March 16, 1911 It answered closely to the description of *Smicronyx spurcus* by Casey.

Anthonomus ochreopilosus Dietz, var. Det. by W. D. Pierce.

Two examples were found on mistletoe by J. D Mitchell, at Victoria, Tex., during January 16-19, 1911. They were considered to be hibernating weevils.

Brachytarsus limbatus Say.

Mr. Mitchell sent one adult weevil which he recorded as having bred out April 2, 1911, from a joint of dead mistletoe acquired on February 7 preceding, at Victoria, Tex. The maturing of this specimen has made possible the fitness of the same specific designation for an anthribid pupa that he obtained in a similar manner on February 25 succeeding. Attached to the latter form was a well-advanced larva of a hymenopterous parasite.

Thysanoes sp. Det. by A. D. Hopkins.

In the course of inspecting mistletoe at Natchez, Miss., on May 26, 1909, the writer's attention was drawn to a few pinhole openings in some plump, green branches On cutting into the injured places a tiny ipid beetle chanced to be exposed within a clean, tight-fitting cell just beneath the bark, but unfortunately the specimen was damaged by the thrust of the knife blade. Again, on June 2, other shoots were observed to be rather thickly riddled with similar perforations Furthermore, the remains of like imagoes were extracted from separate grooves extending longitudinally into the wood from the initial chamber In every instance, however, these penetrations formed only a single passage and contained no more than one denizen if not being entirely vacant. The positions of the subjects within them denoted that during life each individual had burrowed inward until it died. Their bodies had already become permeated with the resinouslike substance produced by the plant. Those sections which had sustained the attacks varied in thickness from three-eighths of an inch to fully an inch, the largest units being most severely bored of all. After examining such mounts of the insect as could be furnished, none being exactly perfect, Dr. A. D. Hopkins assigned them to the genus *Thysanoes*.

Three additional members that also belonged in this group, according to the same authority, were associated with the relative as cited in the next record These adults emerged on March 16 and April 2, 1911, but, as noted, all came from defunct wood.

Stephanoderes sp. Det. by A. D. Hopkins.

Another species of Ipidæ was involved in the outcome of the breeding tests with blighted mistletoe that Mr. J. D. Mitchell conducted at Victoria, Tex. It was represented by a single individual, which Doctor Hopkins determined as above. With regard to the date of its appearance, the one as given in the preceding entry must be applied wherewith mention is made of three participants referable to *Thysanoes* sp. Both kinds, therefore, issued from the same stock.

In reality the depredations by such beetles were first noticed by the writer in similar material procured near Dallas. This event indicated that the borers aptly sought out the particular growth in northern Texas. See remarks on Liopus crassulus Lec.

Laria (Bruchus) ochraceus Schf.

Mr. J. D. Mitchell got just one specimen on green mistletoe at Victoria, Tex., March 8, 1909. It was obviously adventitious in this connection.

Liopus crassulus Lec. Det. by H. S. Barber.

Several dead branches of *Phoradendron flavescens* collected by the writer on April 7, 1909, from oak tree, *Quercus schneckæ*, near Dallas, Tex., were observed to be severely bored in a lengthwise direction. Besides, they exhibited a scattered number of fine shotlike openings on the exterior parts. The different nature of these ravages, as well as the distinct size of the apertures in each case, showed that more than one kind of insect had worked in the stems. Still no pinhole borer could be detected. Some of the joints were penetrated throughout their whole length by the wider tunnels. The latter were thought to have been made by larvæ of a cerambycid beetle. In substantiation of this surmise, adults of *Liopus crassulus* Lec. effected their release from the material on May 4 and 8.

Neoclytus abbreviatus Schf. Det. by E. A. Schwarz.

Larvæ of another cerambycid were found boring in green mistletoe stems by W. D. Pierce at Sabinal, Tex., on June 3, 1910. Adults determined as above appeared later in the summer, thereby completing the breeding test.

Litargus tetraspilotus Lec. Det. by H. S. Barber.

Six examples which answered to the present name were picked off of mistletoe sprigs by J. D. Mitchell on February 8, 1909, at Victoria, Tex. They seemed to be undergoing hibernation at the time

Cycloneda munda Say.

This ladybird was taken on fresh mistletoe by the writer at Natchez, Miss., on May 24, 1909. Although no more than one specimen came to hand, it must be expected to visit such growth as well as other vegetation.

Acylomus ergoti (Walsh) Casey. Det. by E. A. Schwarz.

The presence of this beetle on mistletoe was first noted on March 8, 1909, at Victoria, Tex. Mr. Mitchell then secured four individuals, but he took several more during January 16 to 19, 1911, in the same locality.

Carcinops conjunctus Say. Det. by E. A. Schwarz.

Answering to this identification, a couple of imagoes were submitted by Mr. Mitchell, who caught them on mistletoe at Victoria, Tex., in his searches during January 16 to 19, 1911. Their occurrence on the growth was believed to have been induced for the purpose of passing the winter.

PROBABLE CLERID LARVA, fide E. A. Schwarz.

In concluding his observations upon a batch of material at Victoria, Tex., on April 2, 1911, Mr. Mitchell detected the larval stage of what seemed to be a predaceous beetle occupying a cavity in a piece of defunct mistletoe. No better recognition than that already conveyed in the designative heading could be accorded to it by a technical study.

LEPIDOPTERA.

Sesia sp., probably new, fide A. Busck.

The discovery of still another interesting borer of *Phoradendron flavescens* was reported by J. D. Mitchell, of Victoria, Tex., under date of March 8, 1909. He then wrote as follows: "In the stem of one big branch of mistletoe I found five pupæ and one larva of a lepidoptera, and several empty pupal cases and cells. The occupants in undergoing their larval stage had eaten out the interior of the stem and killed the branch."

By accident two of the former subjects, together with the latter, were crushed in the handling; nevertheless he succeeded in rearing a couple of

moths, which appeared separately on March 22 and 29. These representatives were passed on as cited above.

Owing to the need of extra specimens, especially of the immature forms in perfect condition, for descriptive purposes, this object being prompted by a desire to learn further about the life history of the species, Mr. Mitchell kept on watch for additional material, but not until January 16 to 19, 1911, did he again come upon any growth that proved to be attacked by the insect, and then only a young individual could be procured; yet he saw enough evidence of late work.

On account of the rarity of its kind, the accompanying description of the larva is given, although this example was judged to be no more than half grown. Length of body, extended, 7 mm.; greatest width, 2 mm., but at head, 1.5 mm. General color, pale yellow; head brown, with anterior margin and sutures dusky; tips of mandibles bidenticulated, black. Thoracic legs yellow; base of prolegs and anal claspers ringed with minute black serrulations. Sparsely clothed with pale hairs.

Efforts to rear this single captive met with a mishap which blocked the operations. The writer first placed it in a drilled hole within a joint of fresh mistletoe, after which disposal the orifice was covered with cotton that had been soaked in water Eleven days later, when next observed, the shoot had dried out and become brittle, even though the basal portion, inclusive of its primary fork, had been set in a saturated bed of sand. On splitting open the part containing the tenant in order to see how it had fared, the creature unfortunately suffered a fatal stab from a splinter. It had, however, made vigorous progress by boring ahead to about the span of its body, having moved in a diagonal course from the center of the axis to one side almost against the bark. These results, notwithstanding their incompleteness, denote that the borer might be successfully reared under proper care through artificial introduction into green stock.

Nepticula sp., fide A. Busck.

A small metallic-colored moth was found clinging to a twig of mistletoe by J. D. Mitchell at Victoria, Tex., on March 8, 1909. It was considered to be a mere straggler. Its classification could only be carried to the genus already adduced.

Thyridopteryx ephemeræformis Steph

Several bagworms in their cases were attached to sprigs of mistletoe which W D. Pierce secured at Mansura, La., on April 13, 1909. Also one hanging bag was likewise taken by the writer at Natchez, Miss., on June 2, 1909. No development came from the supply, but the insect doubtlessly belonged to the species aforenamed. It was very likely a wanderer on the growth, as the larva is not known to feed on the plant.

Tacoma feriella Hulst.

On April 22, 1911, while closing up a breeding test with mistletoe at Dallas, Tex., the stock having been obtained just five weeks before in the outskirts of the city, the writer discerned a lepidopterous pupa among the litter. Shortly afterwards, or by May 5, this subject produced a moth which agreed with the identification as applied hereto. A rather brief interval had therefore elapsed between the date of detection and its maturity. The insect might have existed from its start in the larval stage upon some extraneous food on the green growth, if not directly upon the foliage, fruit or bark itself, until it became quiescent. Otherwise it must have strayed from the host tree, *Quercus schneckii,* and then have completed its cycle in confinement with the detached shoots of *Phoradendron flavescens.*

LEPIDOPTEROUS LARVA.

An elongate form whose larval characters delegated it to the order Lepidoptera was abstracted from a section of dead mistletoe by J. D. Mitchell at Victoria, Tex., on February 25, 1911. Being regarded as of no importance, further classification was not attempted.

Supplementary record: The case-bearer as last mentioned in account of the soft scale. *Coccus hesperidum* L., should perhaps be entered in the present list.

LEPIDOPTEROUS EGGS. (Plate I, fig. 1.)

At Mansura, La., on April 13, 1909, Mr. W. D. Pierce got a few eggs on a mistletoe leaf of which a portion had apparently been eaten away. In a group of five of them, four were placed in approximate pairs, leaving one off by itself. Also a row of three additional ova adhered to a stem. All failed to hatch, but they were speculatively supposed to have been laid by a noctuid moth.

HEMIPTERA.

Leptoglossus ashmeadi Heid. Det. verified by same authority.

Different stages of this attractive bug, together with the outer remains of its eggs, occurred on sprigs of *Phoradendron flavescens* which the writer examined at Natchez, Miss., along in the year of 1909. The first specimen came to hand on May 24 and turned out to be a fresh adult. Five nymphs were caught two days later on branches that displayed the eggshells. These young forms were confined with a supply of green shoots, and although only two individuals reached maturity, having passed the last molt, respectively, on May 27 and 30, they accordingly proved beyond question that both had drawn upon the mistletoe for subsistence. They had chosen the stems, however, instead of the leaves, so far as could be seen. Without doubt the others perished because their less advanced development rendered them too feeble to obtain sufficient nourishment on account of the rapid desiccation of the growth.

The tubular shape of the structures that had originally formed the ova, as well as their arrangement in a row, conformed with the features peculiar in such respects to familiarly known cognate species. A total of twenty shells were attached to one twig, while eighteen duplicates appeared on another section of the plant

Since the insect had not been met with before in any personal adventure, Mr. Otto Heidemann's description of it (Bul. Buf. Soc. Nat. Sci., vol. 9, 1909, pp. 237, 238) was looked up and found to fit the grown subjects. Still the author gave no information concerning the habits. An example was then sent to him, with a brief account of the capture. In acknowledgment he verified the determination. His type came from Florida.

Podisus acutissimus Stal.

Just one adult as identified herewith chanced to be distinguished by the writer while inspecting some freshly cut mistletoe on December 19, 1910, at Dallas, Tex. At the same time a leaf having nine eggshells attached to it also drew attention. On being scanned closely with the aid of a magnifier these structures were judged to appertain to the species in hand. Both incidents conjointly signified that the insect possessed an adaptability to breed and maintain itself on such growth, at least during a scarcity of more alluring vegetation. Moreover, a deposition of ova agreeing with the former objects in external looks was taken in a like manner at Sherman, Tex., on January 10, 1911.

YOUNG FULGORID, fide O. Heidemann.

The subjective recognition as accorded here referred to an eruciform stage of a small homopteran. It was detected on mistletoe by the writer at Dallas, Tex., on April 7, 1909. Whether this individual represented a species that should be charged with the act of ovipositing on leaves as noted in the next record still remains an open question.

PROBABLE HOMOPTEROUS OVIPOSITION. (Plate I, fig. 2.)

Mr. J. D. Mitchell submitted mistletoe leaves picked by himself at Victoria, Tex., during January 16 to 19, 1911, which disclosed a capricious mode

of oviposition by some inferior insect. In all probability the culprit belonged in one of the minor groups of the Homoptera. The ova were inserted generally in a chain through minute slits in the epidermis on both faces of the leafy surface, but the upper side revealed a greater number of the rents. Their nature and positions can best be comprehended by turning to the reproduction of a photograph, as already indicated.

Since the eggs failed to hatch, however, nothing more than provisional deductions could be ventured in explanation of their origin. On seeking the opinions of certain specialists, the following conjectures were expressed: Dr. W. D. Hunter inferred that the committals might have been done by a membracid, if not a near relative Prof. Herbert Osborn concurred with this idea, remarking that he believed a jassid could have been concerned equally as well The problem is still further complicated by the preceding observation.

APHIDIDÆ.—*Macrosiphum* sp., undescribed, fide C. E Sanborn.

On October 29, 1908, Mr F C Bishopp happened to locate a small colony of aphids on mistletoe growing upon an Osage orange or bois d'arc tree, near Dallas, Tex The live specimens were promptly sent to Prof C E Sanborn, then at College Station, Tex , for study. The latter undertook to breed them, but a grass fire spread under the tree that was utilized for the experiment and destroyed all of the lot He had satisfied himself, however, that these subjects represented an undescribed species as reported above

In addition the writer took a single alate form on a plant in his first collection at Plano, Tex., on December 12 following Professor Sanborn also assigned it to the same genus. Besides, a few individuals of a kindred appearance were removed from shoots when gathered in person at Alexandria, La., on February 27, 1909. Their dead condition unfortunately disqualified them for comparative purposes. So far as personally known, the only prior mention of the occurrence of any aphid on such growth is given in the remark by W. H. Ashmead supplementary to Mr Schwarz's paper. (See Bibliography)

COCCIDÆ (Primary considerations)

By serving as harbors for scale insects the various mistletoes assume a relative position of some economic importance. The appended bibliography includes quite a number of coccid identifications heretofore recorded from different plants of the family Loranthaceæ The following contributory notes, however, apply solely to the American mistletoe

Lecanium nigrofasciatum Perg The terrapin scale. Det by J G Sanders and Theo Pergande. (Plate II, figs 1 and 2)

Among the coccids that have come to notice in the present survey the above vandal proved to be the chief one. It was first directly met with at Plano, Tex , on February 12, 1909, occurring most numerously on stems, but just scatteringly on leaves. The specific determination was kindly furnished by the authorities as just cited, together with a comment reading thus: "This is a very interesting new host-plant record for the species, although it has been previously reported from various points in Texas." Shortly afterwards the former specialist wrote that a second batch of like material had been received at the Bureau of Entomology, Washington, D. C., this accession having come from Richland, Mo.

About the same time the fact was ascertained that Mr. F C. Bishopp had found scale insects on mistletoe near Dallas, Tex , during October 29, 1908, of which some might have answered to the preceding name. At least, a *Lecanium* sp. was represented, according to the statement of Prof. G. W. Herrick, who had accepted the specimens for diagnosis.

The likelihood that Mr. Bishopp deserved credit for priority of record in connection herewith was strengthened by the writer's own acquisition of examples of what appeared to be the aforesaid insect upon similar growth at Dallas, Tex., on December 19, 1910. Their smaller size in comparison with those of the initial lot was clearly due to prematureness.

At Mansura, La., on April 13, 1909, Mr. W. D. Pierce obtained a branch literally encrusted with old stages. Many of the bodies dropped off, however, before the photographs could be made, as shown in the plate, to which attention is already called. Then on May 24 of the same year, at Natchez, Miss., a very scant colony chanced to be spied in person. From Victoria, Tex., Mr. J. D. Mitchell transmitted a few small infested sprigs collected by himself during January 16 to 19, 1911. The forms, moreover, were sparingly distributed and undersized.

Pseudococcus sp., fide E. R. Sasscer.

Specimens of a mealy bug, as just designated in part, were first detected by the writer in an old larval cell of the weevil *Smicraulax tuberculatus*. This disclosure attended an inspection of stock which was procured at Plano, Tex., on February 12, 1909.

Under date of March 8 next following, Mr. J. D. Mitchell, of Victoria, Tex., sent a hollow stem resulting from the depredations of *Sesia* sp., but which contained eleven immature forms whose structural characters and flocculent vestiture likened them to the precedent subjects in all essentials, debarring size. Again during his reconnoissance of January 16 to 19, 1911, he came across a joint having a similar cavity, that in this instance was packed full with such insects.

In material that was personally collected at Dallas, Tex., on December 19, 1910, a stray adult happened to be found hiding within an emergence hole of the aforementioned species of weevil. Furthermore, a brood of young scurried out from the interior cranny when it was opened.

All of these examples closely resembled a number of individuals that Mr. Sasscer considered to be *Pseudococcus citri* Risso, which had infested green cotton stalks at Plano, Tex., being taken in June and July, 1910. The possibility of their exact identity is to be expected. No other record is known of either mistletoe or cotton as affording a provident resort for any member of the genus.

Aspidiotus camelliæ Sign. Det. by J. G. Sanders.

A number of scales of this description were secured in person at Alexandria, La., on February 27, 1909. They were attached to both stems and leaves. The same kind, however, appeared to be rare on branches, so far as Mr. W. D. Pierce was able to observe during his visit at Mansura, La., on April 13 ensuing.

It has already been listed for California by E. O. Essig and C. F Baker. (See Bibliography.)

Supplementary record: An infestation on a deadfall, which was also blackened with sooty mold, this material being picked up by the writer beneath a water oak in Tallulah, La., on May 3, 1919, proved to be due to the same species. Mr. E. A. Sasscer identified it.

Coccus hesperidum L. The soft scale. Det. by J G. Sanders.

The lodgement of this adaptive pest on some sprigs, inclusive of their foliage, was noted by the writer at Alexandria, La., on February 27, 1909.

A previous report concerning it under like circumstances has been given by W. A. Hooker. (See Bibliography.)

Supplementary record: At Baton Rouge, La., on March 30, 1917, a few specimens were personally taken on leaves, being attended by the Argentine ant, *Iridomyrmex humilis* Mayr. Furthermore, on a part of this material small spots of parenchyma had been eaten away by two tiny unrecognized larvæ, each occupying a spine-shaped case.

Ceroplastes cirripediformis Comst. The barnacle scale. Det. by J. G. Sanders.

A twig which exhibited a few typical forms of the present coccid was saved by Mr. W. D. Pierce while stopping at Mansura, La., on April 13, 1909.

The first record of the species in relation to the same host plant has been published by W. A. Hooker. (See Bibliography.)

Supplementary records: In June, 1913, the writer happened to notice an abundant occurrence of the above insect on shoots that had broken loose from a large live oak after it had been cut down on the university campus at Baton Rouge, La.

A fresh branch which had fallen from the top of another oak tree on the same campus was also much infested when seen on March 30, 1914. Mr. E. A. Sasscer verified the determination.

When, on June 13 of the same year, several sprigs which had dropped from like trees during a hard wind of the preceding day were found beset with young stages well distributed over all parts. Some old forms were attached to a thick piece and its forks. Their identification was pronounced correct by Mr. E. A. Sasscer.

Again a heavy infestation was observed on October 27 succeeding, this case being brought to attention on trimmings.

A remark of interest might be added concerning the protection of these trees in the past against the ravages of mistletoe. All were said to have been thoroughly cleaned during January and February of 1909. Men were then employed to climb them and break off the infesting growth, but of late years it has become quite conspicuous again.

Chionaspis sp., fide G. W. Herrick.

The incomplete classification as rendered here pertained to a kind of scale which Mr. F C. Bishopp got near Dallas, Tex., on October 29, 1908. In reality it was associated with a *Lecanium* sp., probably *L. nigrofasciatum* Perg., of which an account has been given.

HYMENOPTERA OTHER THAN BRED WEEVIL PARASITES.

Owing to the disposition of various ants to nest in odd cavities and mingle with scale insects, a number of different species of their class has been taken from mistletoe plants. The following list has therefore been compiled, together with the available records.

Strumigenys louisianæ Roger.

At Victoria, Tex, on March 8, 1909, Mr. J. D. Mitchell secured a whole colony of this kind of formicid, including the queen, with all other forms down to the helpless larvæ. These individuals occupied a burrow that had first been made and later vacated by *Sesia* sp.

Camponotus fallax (Nyl.), subsp. *discolor* Buck.

In conjunction with the aforementioned seizure another formicine community having a complement of forces was found in a similar recess. The distinctive traits of the grown members referred them to the cognomination as given hereto. Subsequently, on April 7, at Dallas, Tex., the writer intercepted a rambling worker upon a branch. It possessed all the characteristics as before represented in sort.

Cremastogaster lineolata Say.

A few workers which fell into the hands of Mr. J. D. Mitchell while on his scouting trip around Victoria, Tex., during January 16 to 19, 1911, answered to the present appellation.

Solenopsis geminata Fab.

Several examples of this common forager were collected under the same circumstances as in the preceding case.

Prenolepis (Nylanderia) vividula (Nyl.), subsp. *melanderi* Wh.

One winged male whose taxonomic features linked it with the above particularization was also acquired in the survey as just noted.

Pseudomyrma gracilis (Emery), var. *mexicana* Roger.

Agreeing with this discrimination, a single worker came to notice. Its capture coincided with that of the former specimen.

Pseudomyrma brunnea F. Sm.

A typical worker of this identity was involved like the foregoing relative.

Iridomyrmex humilis Mayr. The Argentine ant

The only record of this pest in connection with mistletoe relates to its attendance upon the soft scale, *Coccus hesperidum* L., at Baton Rouge, La., on March 30, 1917. See reference to its accommodator.

COMMENT.

Not all of the other hymenopterous insects that claimed attention can justly be regarded as having gained any particular advantage through their association with mistletoe. While a conspectus of the material was necessarily limited by the restrictions which supervened, yet the actual facts may be of some value.

CHALCIDOID, species to be determined.

One green-colored fly of the nature as implied in advance matured from a supply of dead shoots after they had been kept awhile under observation by Mr. J. D. Mitchell at Victoria, Tex. This breeding test was instituted on February 7, 1911, the date of his collection of the stock. The advent of the stranger tended to convey the impression that it was a parasite of *Brachytarsus limbatus* Say, which then infested some of the stems. Mention has heretofore been made of a parasitized pupa in reference to the same weevil.

CHALCIDOID, undetermined species.

Among the specimens which the writer brought from Natchez, Miss., was a lone individual whose status has not yet been established beyond that of its kinship as just denoted. Its interception chanced to be effected on May 24, 1909. It was presumed to have been a vagrant in respect to its lodgement at the time.

PROCTOTRYPID, species awaiting determination

The solitary adult in this case was resting on a left when found by the writer at Alexandria, La., on February 27, 1909. It belonged in the category as implied beforehand. According to what is known about the species composing this group, most all of them have parasitic habits. The present member, therefore, might have been on the lookout for prey of the same kind that instigated the malformations which are described in the next entry. Such speculation, however, imposes a vague proposition.

PROBABLE HYMENOPTEROUS GALL FORMATION. (Plate III, figs. 1 and 2.)

Mr. W. D. Pierce reserved quite a lot of branches from his pickings at Mansura, La., on April 13, 1909, the fruiting pedicels of which were badly distorted by gall formations. Nearly all of the excrescences were perforated with tiny holes that had obviously permitted the escape of some sort of producer from within. The best conception of what the agent could have been in nature inclined to a hymenopteran of apt proclivity. Since it had ceased operations, no representative could be secured. A slight suspicion, however, was placed upon the forenoted proctotrypid as having been a likely enemy if not otherwise concerned with the same gall maker in the locality, at least, where the inimical wasp happened to be caught. Samples of the growth which most strikingly showed the deformities are depicted by photographs as reproduced in the plate already designated.

In addition, a somewhat similar plight came under observation at San Antonio, Tex., on April 10, 1911. The sprigs in this instance were personally obtained in a thicket of tall mesquite. The ill condition appeared to have

been due to a recent blasting of a majority of the buds on the fructificative appendicles. No positive evidence of any insect attack could be distinguished, yet in view of the possibility that such a perpetration had become obscured if really committed, the abortions were reflectively looked upon as having perchance been caused by inflictive stings consequent to the act of an adversary in depositing its eggs. Owing to the fact that the latter defects conformed in many ways with certain features of the precedent incitement, this likeness on their part was strongly suggestive of an incipient visitation by a provoker possessing a congenerous if not a specific relationship to the one in the prior affair.

Cocoons of *Apanteles* sp., fide H. L. Viereck.

On sorting over a batch of material that had just been gathered at Dallas, Tex., the date being December 19, 1910, a cluster of small, brownish cocoons attracted the eye of the writer. These objects were attached to a stem in a crosswise position, being arranged side by side in an even row, with the exception that one of the number happened to be elevated above the others at about midway in the chain. All of them proved to be empty, and only two out of the aggregate of twelve cases retained a terminal cap. Their origin was ascribed to parasitic larvæ of the above attribution.

Cocoons of *Microplitis* sp, fide H. L Viereck.

While on his quest during January 16-19, 1911, Mr. J. D Mitchell of Victoria, Tex, procured a couple of leaves, each of which had a miniature cocoon adhering to it Neither of these envelopes was tenanted at the time, but the before-named expert who examined them arrived at the decision as aforestated respecting their construction

ORTHOPTERA

Œcanthus sp, and depositations of eggs.

In the assortment of material which Mr. W. D. Pierce acquired at Mansura, La., on April 13, 1909, he included a few stems containing the eggs of a tree cricket. The structural aspects of the ova and the manner in which the latter had been inserted along the axis of a shoot afforded unmistakable evidence inculpating such an insect. Moreover, a newly hatched eruca that embodied the distinctive characters of the forecited genus chanced to be detected at the next inspection which was effectuated immediately upon the delivery of the stock in Dallas, Tex. This creature and probably others corresponding to it had doubtlessly emerged in transit. Still the lack of further developments occasioned some disappointment.

Evidence of Oviposition by *Stagmomantis carolina* L.

The implication of this mantis happened to be noted coincidently with that of the former orthopteran. Its involvement was manifested in the shape of a mass of eggs which typically appertained to the species. The ova, however, failed to hatch.

MINOR INSECTS.

Occurrence of a Psocid with an Inimical Mite.

The greater share of the minor insects that were found on mistletoe belonged by right to the family Psocidæ. A perplexing instance of such an attraction by one of their kind happened to be taken into account by the writer at Alexandria, La., on February 27, 1909. So far as could be seen, no more than two leaves were affected by the occurrence. Attention was drawn to them by reason of their blotchy look. At first sight the blemishes were thought to be small dabs of a whitish substance, but under ample magnification through a lens they proved to be clusters of minute spherical bodies constituting a total of thirty-one perfect eggs and twelve punctured shells of like deposition. These objects were so jumbled together in clusters that they reflected the utmost disorder and irregularity in the manner of their disposal.

The effects of despoilment were manifested in a singular way. All of the pilferages revealed the same phases of violence, the cause of which, on being considered deeply, resolved itself into an intricate affair. The distinguishing mark by which the defective samples were singled out consisted of a barely visible fracture upon one side of each of them. Only by a very thorough scrutiny could these faults be discerned. Since the clefts seemed to be sunken within the surface, thereby leaving dim indentations in their places, the best definition of them conduced to show that every breach had been produced by a forceful trust from without.

These observations, furthermore, brought to notice the presence of a few prowlers in the form of a mite which lurked beneath their scanty networks of extremely fine webs. The latter had been spun upon some of the ovulated clumps as well as along the edges of them. On noting the savage guise of the agressor, it was immediately blamed for the mischief that had been done. In fact, the rapacious nature of this acarid was conclusively evinced by the similar character of the subsequent raids which attended its multiplication in confinement with the material. Even under these circumstances, several weakling psocids hatched out on March 13, but being menaced by the foe, not the least surprise was excited by their untimely deaths within the next six days.

For additional remarks concerning the raider, see under citation of *Monieziella longipes?* Bks. in list of Acarina

Pterodela pedicularis L.

At Dallas, Tex., along in April, 1911, while closing up the breeding tests with three local collections of stock that had been obtained at weekly intervals during the preceding month, the writer came upon the above species of Psocidæ. This insect had bred abundantly on the dry, musty branches and leaves.

Cæcilius sp., probably not described, fide N. Banks

A single specimen as referred to here chanced to be collected in person at Natchez, Miss., on May 24, 1909.

Peripsocus sp., near *permadidus* Walsh, fide N. Banks

Just one example of this characterization was secured by Mr. J. D. Mitchell at Victoria, Tex., on March 8, 1909.

Troctes divinatoria Müll.

Numbers of this wingless corrodentian occupied an empty cell of the weevil *Smicraulax tuberculatus* Pierce, in material that the writer gathered on December 19, 1910, at Dallas, Tex. Another colony was located at the same time infesting a dead, riddled stem.

Entomobrya multifasciata Tull. Det. by J. W. Folsom.

This collembolous scavenger happened to be spied among bits of detritus that had been shed by the branches which Mr. W. D. Pierce brought from Mansura, La., under date of April 13, 1909. Only a few individuals, however, could be detected.

Entomobrya sp., exact identity not recognized, fide J. W. Folsom.

Two frail nondescripts which closely resembled the foregoing representatives fell into the hands of the writer at Natchez, Miss., on May 25, 1909. After accepting them for study, Doctor Folsom stated that he could not then decide upon their specific identification, but first desire some European forms for comparison.

ACARINA.

Monieziella Longipes? Bks. Det. by N. Banks.

This ravager was taken with the psocid eggs as mentioned heretofore under Minor Insects. Its brownish, hard-crusted appearance plainly betokened a fierce disposition at the outset, while its behavior gave assurance that it

really did possess a greedy nature. It thrived well in confinement, evidently feeding upon the ova by extracting their contents and later killing the young insects which issued from such of the former as had escaped harm. Even at the last, it seemed to derive subsistence for a few days from the dead bodies themselves. Although the infested leaves became coated with mold, its activities were not hindered in the least.

The above specialist reported his determination of the specimens as follows: "The mite is one of the tyroglyphids, of the genus *Monieziella*, perhaps *M. longipes* Bks. All the species of the genus are predaceous."

Oripoda elongata Bks. Det. by N. Banks.

Several individuals as assigned here inhabited some of the old abandoned cells of the weevil *Smicraulax tuberculatus* Pierce, belonging in an accession of stock that the writer selected at Natchez, Miss., on May 24, 1909. According to the authority as before named, this acarid feeds on decaying vegetable matter.

Gamasus sp., immature, fide N. Banks.

Examples which could only be classified this far were secured at the same time under like conditions as have been noted in the foregoing record. Mr. Banks expressed his opinion that such forms probably subsist by plunderage.

Liacarus sp., fide N. Banks.

Only a couple of specimens of this sort chanced to be perceived on the exuvial casts of the weevil *Smicraulax tuberculatus* Pierce, which remained inside of the original cavity within one of the branches that the writer got on April 7, 1909, at Dallas, Tex. Mr. Banks stated that they represented "a species of *Liacarus*, one of the oribatid mites, a scavenger, and not parasitic. It had doubtlessly fed on decaying matter in the cell. Various kinds of mites are liable to be found in such places and have no relation to the insect making the hole."

Another individual that might have been an identical form happened to be spied in a similar mine at Sherman, Tex., on January 10, 1911, but as it was inadvertently lost, nothing could be learned about its status.

Oribatula n. sp., fide N. Banks.

At Sabinal, Tex., on June 3, 1910, Mr. W. D. Pierce came upon a mass of mites which had established themselves in a cerambycid burrow. In fact, this space was almost crammed full with the colony. Although the members were readily referred to the genus as just cited, their peculiar distinctions specifically set them off as being new to science. Later developments proved that the originator of the chamber was *Neoclytus abbreviatus* Schf., the record of which has previously been given.

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Gives descriptions of the following new species of scales on mistletoe. *Porococcus pergandei*, host from lime tree, *Cuantla*, p 427, *Porococcus tinctorius*, host from oak, *Ameca*, p 427, and *Diaspis phoradendri*, doubtless on *Phoradendron*, Cuantla, p 437. Regarding the last species the author has stated in letter "No doubt a native insect and nothing particular to do with *D. visci*"

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Cites the following species collected on mistletoe, all of which are reported in the present paper *Pseudomyrma gracilis mexicana*, *Pseudomyrma brunnea*, *Solenopsis geminata*, *Cremastogaster lineolata*, *Strumigenys louisianæ*, *Prenolepis (Nylanderia) vividula melanderi*, and *Camponotus fallax discolor*

PIERCE, W D, assisted by R A CUSHMAN and C E HOOD, under the direction of W. D HUNTER 1912—The insect enemies of the cotton boll weevil (U S Dept Agr, Bu Ent, Bul 100, issued April 3)

Gives the following citations· *Eurytoma tylodermatis* and *Cerambycobius cyaniceps*, p 50; *Catolaccus hunteri*, p 51, and *Microbracon mellitor*, p 58, all as parasites of *Smicraulax tuberculatus* in mistletoe stems States that *Smicraulax tuberculatus* is known to breed in stems of *Phoradendron flavescens* in Texas, Louisiana and Mississippi, being parasitized by the above-mentioned species, p 76, and it is also cited in list of host plants, p 80

PIERCE, W. D 1913.—Miscellaneous contributions to the knowledge of the weevils of the families Attelabidæ and Brachyrhinidæ. (Proc U. S. Nat. Mus., v. 45, May 23, pp. 365-426.)

Cites *Pandeleteius cinereus* Horn, taken at Dallas, Tex, March 6, 1909, breeding in twigs of *Phoradendron flavescens* on *Hicoria alba*, Pierce and Tucker, p. 404. Instead of *Hicoria alba*, the specific name of the host tree should be *Quercus schneckii*.

SCHAEFFER, CHAS. *1906.*—New Rhynchophora. (Can. Ent., 38, October, pp. 339-344.)
Cites *Cryptorhynchus lacteicollis* Champ.: "Taken by beating mistletoe growing on walnut," in Arizona, p. 344. (Also, see Schwarz, E. A.; footnote)

SCHRANK, FRANZ VON PAULA. *1781.*—Enumeratio insectorum Austriæ indigenorum.' (See Fernald, Mrs. M. E.)

SCHWARZ, E. A. *1901.*—On the insect fauna of the mistletoe. (Proc Ent. Soc Wash, 4, pp. 392-394.)
Records, on authority of Kaltenbach, four species from *Viscum album* of Europe *Psylla visci* Curt. (*exophila* Frfd.), *Aspidiotus visci* Frfd, and two cerambycids of the genus *Pogonocherus*. Reports from *Phoradendron* in the United States *Lecanium phoradendri* Ckll., and an undescribed psyllid from California, collected on *Phoradendron macrophyllum*. A coccinellid, *Cephaloscymnus occidentalis* Horn, an enemy of the scale *Lecanium phoradendri*, on *P. macrophyllum*, was rare in Arizona. Curculionid larvæ boring in branches proved to be an undescribed *Otidocephalus*,* its deserted galleries being occupied by ants, *Cremastogaster* sp, which attended the scales The dead and dying branches resulting from the attacks of the weevils were bored by scolytid beetles belonging near the genus *Stephanoderus*. A bostrychid borer bred out as an undescribed species of *Amphicerus*. Lycænid larvæ which fed on leaves bred out *Thecla halesus*.
In remarks, Mr W. M. Ashmead stated that he had seen a scale insect and an aphid on mistletoe at Jacksonville, Fla, but he had not worked them up.

SIGNORET, VICTOR. *1876*—See Fernald, Mrs. M. E

WHEELER, W. M. *1912.* Notes on a mistletoe ant. (Jr N Y Ent Soc, 20, June, pp 130-134.)
Reports occurrence of ant colonies of the species *Cremastogaster arizonensis* Wh. in burrowed stems of *Phoradendron flavescens* var *villosum* growing on live oaks, *Quercus emoryi*, in the Huachuca mountains, Arizona A species of coccid described by Prof T. D. A. Cockerell as *Pseudococcus phoradendri*, n sp., was invariably found attended by the ants in their nesting cavities. Author refers to observations made by Mr E A. Schwarz in his paper, "On the insect fauna of the mistletoe" (Proc Ent. Soc Wash, v. 4, 1901, pp. 392-394.) The following species mentioned by Mr Schwarz are cited. *Lecanium phoradendri, Cephaloscymnus occidentalis*, an undescribed species of *Otidocephalus* which caused the burrows, *Cremastogaster* sp, a species belonging near *Stephanoderus, Amphicerus* sp, and *Thecla halesus*. The ants (*Cremastogaster*) and the borer (*Otidocephalus*) as referred to in the latter respects are believed to be identical in each of the two cases
Author describes female and male forms of *Cremastogaster arizonensis* and gives Professor Cockerell's description of *Pseudococcus phoradendri*.

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* Since described by Mr. Chas. Schaeffer as *Otidocephalus arizonicus*, but without mention of its habits. (New Rhynchophora, II. Jr N. Y. Ent Soc, 15, June, 1907, p 76)

EXPLANATION OF PLATES.

PLATE I

FIG. 1. Probable lepidopterous eggs on mistletoe leaf and stem, enlarged six diameters.

FIG. 2 Leaf of mistletoe, showing scars of oviposition by supposed homopterous insect, enlarged four diameters.

PLATE II.

FIG. 1. Mistletoe stems infested with the terrapin scale, *Lecanium nigrofasciatum* Perg., natural size.

FIG. 2. Section of former enlarged six diameters.

PLATE III.

FIG. 1. Gall formations on fruiting pedicels of mistletoe, natural size.

FIG. 2. Bunch of galls enlarged six diameters, showing emergence holes of supposed hymenopterous producer.

All from original photographs by the author, except that acknowledgment is due Mr. G. N. Wolcott for assistance in making the original of figure 2, plate I.

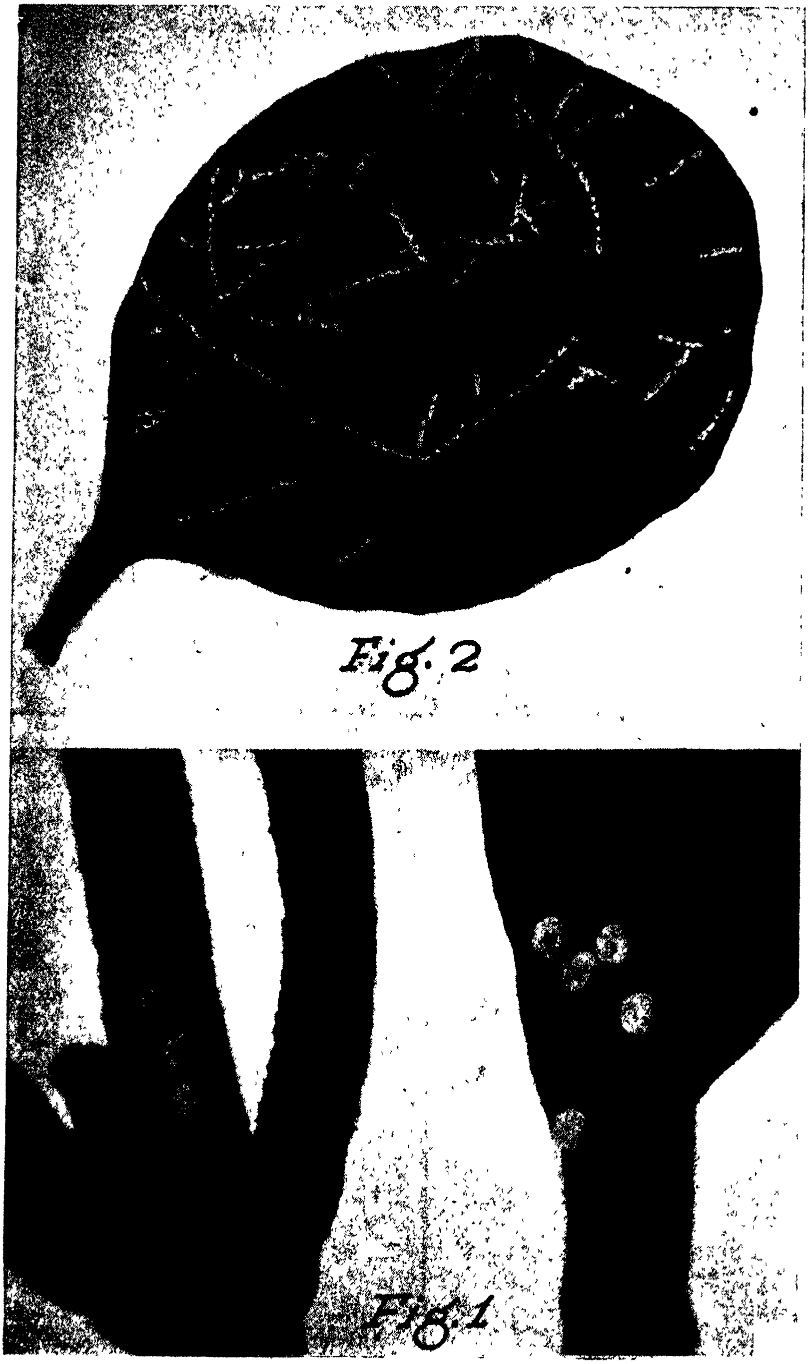

Fig. 2

Fig. 1

TRANS. KANSAS ACAD SCI , VOL. XXX PLATE II

Fig. 1


Fig. 2
Fig. 1

Notes on Some Fungi from Eastern Kansas.

GUY WEST WILSON.

During the writer's sojourn in Kansas a small collection of fungi, chiefly parasitic, was made at Lawrence. Some of these were, of course, very common and widespread, but others were among those species which deserve to be listed as rare. Moreover, the majority of the records of fungi from Kansas are from localities in the western two-thirds of the state. It therefore appears desirable to place on record a list of the species collected. Notes have been added on a very few species of which no specimens are now at hand, but these are of such abundance in the localities noted that they may easily be collected at any time. Duplicates of the majority of the species are in the herbarium of the University of Kansas and a portion of them are at the Kansas State Agricultural College in Manhattan.

The classification and nomenclature adopted is in the main that in common use among American mycologists. The Uredinales have all been named according to the scheme of classification used by Doctor Arthur in the North American Flora, while the Hyphomycotes have all been grouped under Moniliaceæ as in previous papers on parasitic fungi.

Family PERONOSPORACEÆ

1. *Rhysotheca halstedii* (Farlow) Wilson.
   On young plants of *Ambrosia trifida* L. Not abundant.

2. *Rhysotheca crevanii* (Peck.) Wilson.
   Very abundant on *Geranium carolaniana* Walt.

3. *Peronospora plantaginis* Underwood.
   Not common, but at one locality rather plentiful on *Plantago aristata* Michx. This species has been collected in but two other localities, the type locality at Auburn, Ala., and at West Raleigh, N. C. The species is difficult to detect in the field, as the conidiophores are produced rather sparingly on the discolored areas of the host. The infection is easily mistaken for the work of insects unless very careful inspection is made.

4. *Peronospora lepidii* (McAlpine) Wilson.
   Conspicuous and not uncommon on *Lepidium densiflorum* Schrad. Probably present on other crucifers.

5. *Peronospora corydalis* De Bary.
   Not uncommon on *Capnodes aureum* (Willd.) Kuntze.

6. *Peronospora parasitica* (Pers.) Fries.
   Common on *Sophia intermedia* Rydberg. Probably present on a number of other hosts of the family, as this is one of the most widespread species of the genus.

Family ALBUGINACEÆ.

7. *Albugo candida* (Pers.) Rousel.
   Very common on *Bursa bursa-pastoris* (L.) Britton, *Lepidium densiflorum* Schrad., *Sophia intermedium* Rydberg, and *Sisymbrium officinalis* (L.) Scop. A widespread species. Probably also occurring on other crucifers.

8. *Albugo Ipomoeæ-penduraneæ* (Schw.) Swingle.
   Common on *Ipomoea hederacea* (L.) Jacq.

9. *Albugo bliti* (Biv.) Kuntze.
Rather abundant on *Amaranthus hybridus* L. and *Acnida tuberculata Moq.*

10. *Albugo portulacæ* (DC.) Kuntze.
Common in early summer on *Portulaca oleracea* L.

Family ERYSIPHACEÆ.

11. *Erysiphe graminis* DC.
On *Poa pratensis* L. Common and destructive in shaded, moist places, but as usual no perithecia formed.

12. *Erysiphe polygoni* DC
On *Galium aparine* L. Very abundant on this host, which it completely destroyed after heavy rains. This is one of the species of the family with a remarkable range of hosts, so its collection is to be expected on a wider range of plants.

Family AMPHISPHÆRIACEÆ.

13. *Caryospora putminum* (Schw.) De Notaris.
On peach pits which were exposed to the weather during the winter.

Family USTILAGINACEÆ.

14. *Ustilago zeæ* (Beckm) Unger.
Common and somewhat destructive on *Zea mays* L Not collected.

15. *Ustilago oxalidis* Earle & Tracy.
Found on one clump of *Oxalis stricta* L. One of the rarer species of the genus

16. *Sphacelotheca sorghi* (Link) Clinton.
On *Sorghum vulgare* Pers. Common and destructive on kafir in some localities.

Family TILLETIACEÆ.

17. *Entyloma veronicæ* Lagerh.
On *Veronica peregrina* L. The most western record, apparently, for this rather rare species

Family PUCCINIACEÆ.

18. *Gymnosporangium juniperi-virginianæ* Schw.
Rather common on *Juniperus virginiana* L. The æcial stage not collected.

19. *Nigredo seditiosus* (Kern) Arthur (= *Uromyces* Kern).
I on *Plantago aristata* Michx. The telia of this species is recorded from Kansas on *Aristida dichotomum* Michx. Indeed, the type collection of the species is from Wa Keeney on this host. So far as the author is aware this is the first collection of the æcia of this species in the state. This stage is very inconspicuous and easily overlooked. Careful search on various species of *Plantago* resulted in a single collection.

20. *Nigredo Hordei* (Tracy) Arthur (=*Uromyces* Tracy).
II, III on *Hordeum pussillum* Nutt. While this collection is predominatingly uredinial, a few immature teliospores are present in the sori. Abundant in one field.

21. *Nigredo caladii* (Schw.) Arthur (= *Uromyces* Farlow).
I on *Arisæma dracontium* (L.) Schott. and *A. triphyllum* (L.) Schott. Not abundant, but a very conspicuous rust.

22. *Nigredo Polygoni* (Pers.) Arthur (= *Uromyces* Fuckel).
II on *Polygonium erectum* L. Not common, but abundant where found.

23. *Nigredo caryophyllina* (Schrank) Arthur (= *Uromyces* Winter; *U. dianthi* Nissel).
II, III, on *Dianthus caryophpllus* L. Common, but not destructive, in greenhouses at Lawrence.

24. *Nigredo proeminens* (DC.) Arthur (= *Uromyces euphorbiæ* Cooke & Peck).
I on *Chamæsyce maculata* (L.) Small and *C. serpens* (HBK) Small.
II on *C. maculata* (L.) Small and *Poinsettia dentata* (Michx.) Small.
A common rust, the æcial stage especially being quite conspicuous from the erect habit of the host.

25. *Nigredo Spermacoces* (Schw.) Arthur (= *Uromyces* M. A. Curtis).
III on *Diodia Teres* Walt. in southeastern Kansas. Collected in Labette county.

26. *Dicæoma poculiforme* (Jacq.) Arthur (= *Puccinia graminis* Pers.).
II on *Triticum vulgare* L.

27. *Dicæoma impatientis* (Schw.) Arthur (= *Puccinia* Arthur).
II on *Elymus virginica* L. Not common. The æcia on *Impatiens* was not collected.

28. *Dicæoma Caracis-erigerontis* Arthur (= *Puccinia* Arthur).
I on *Erigeron ramosus* (Walt.) BSP. Not abundant. Telia not collected.

29. *Dicæoma Asparagi* (DC.) Kuntze (= *Puccinia* DC.)
III on *Asparagus officinalis* L. Not common, and appearing too late to be seriously destructive. Seen only on cultivated asparagus.

30. *Dicæoma polygoni-amphibiæ* (Pers) Arthur (= *Puccinia* Pers.).
I on *Geranium carolanianum* L. Not abundant. Telia not seen.

31. *Dicæoma helianthi* (Schw.) Kuntze (= *Puccinia* Schw).
II on *Helianthus annuus* L. Abundant on sunflowers.

32. *Allodus podophylli* (Schw.). Arthur (= *Puccinia* Schw.).
I on *Podophyllum peltatum* L. Neither common nor abundant. A short-cycle form without uredinia. Telia not seen.

33. *Bullaria taraxaci* (Plowr.) Arthur (= *Puccinia* Plowr.).
II on *Taraxacum officinale* Willd. Abundant. Scarcely a plant of the host on the University campus unaffected.

34. *Dasyspora xanthi* (Schw.) Arthur (= *Puccinia* Schw.).
III on seedling *Xanthium* sp. Abundant. A short-cycle form with telia only

Family POLYPORACEÆ.

35. *Hexagonia alveolaris* (DC.) Murrill (= *Favolus canadensis* Klotzsch).
Common on fallen twigs.

36. ***Fomes Robiniæ*** (Murrill) P. & D. Sacc.
On living ***Robinia pseudo-acacia*** L. Not uncommon on the black locust about Lawrence.

Family PHALLACEÆ.

37. *Phallus ravenelii* B. & C.

During the spring and early summer, and again after the rains of early autumn, this species was abundant on lawns in Lawrence, and, according to Prof. W. B. Wilson, also at Ottawa. Unlike this species in more eastern states, there was very little of the fœtid odor given off, frequently not enough to make the plants unpleasant out of doors.

Family PHOMATACEÆ.

38. *Septoria gaurina* E. & K.

On *Gaura parviflora* Dougl. Common and to a considerable extent defoliating the host.

39. *Septoria convolvulæ* Desmaz.

On *Convolvulus sepium* L. Common and causing some damage to the host.

40. *Septoria Lactucæ* Pass.

On *Lactuca scariola* L. Abundant on this weed.

Family MELANCONIACEÆ

41. *Colletotrichum gramineum* (Gesati) G. W. Wilson.

On *Hordeum pusillum* L. Abundant on this host, and probably also on other grasses.

Family MONILIACEÆ.

42. *Ramularia decipiens* E. & E.

On *Rumex crispus* L. Conspicuous and common on this host, and probably also on other species of the genus.

43. *Cercospora œnotheræ* E. & E.

On *Anogra albicaulis* (Pursh.) Small. Defoliating a cultivated clump of the host plant.

Edible Mushrooms of Kansas.

ELAM BARTHOLOMEW

It is often too true, "In the course of human events," that he whose knowledge is the most superficial in a given line of attainment is usually the one who can speak, and sometimes write, the most glibly on said topic, whether it be in politics, morals, religion or trade, or in the deeper realm of scientific research. Yet to elaborate on a theme with the thought to bring enlightenment to the hearer or reader presupposes that the effort should come through the medium of some one who is qualified, in a fairly marked degree, to present the topic in an edifying manner; so, as there are two horns to the dilemma, I presume the safer course for me will be to grab hold of both horns and let the dilemma shift for itself. I believe this is the first time that a general discussion of the edible mushrooms of Kansas has been undertaken, and as this paper is calculated to be merely academic in scope, it is to be hoped that in the near future some one better qualified may build a worthy superstructure on the foundation that I am laying to-day.

My remarks in this paper will be confined to my own observations and experiences in this state. While we have, perhaps, more than a hundred species of edible mushrooms in Kansas, I will consider only about twenty-five

of the commonest and most noteworthy species. In the United States there are more than one thousand species of mushrooms, including the puffballs, and I think it can be safely said that you can count on the fingers of your two hands all the species that are known to be violently poisonous.

In this discussion I shall confine myself to only three family groups of the fungi, viz., the Agaricaceæ, the Lycoperdaceæ, and the Helvellaceæ, or, in other words, the agarics, the puffballs, and the morels. In the first group we have the well-known common meadow mushroom, *Agaricus campestris,* of commerce, both in and out of cultivation. With its short stipe, white cap or pileus, and pink gills or lamellæ, it needs no additional description, as its range is world-wide Out of cultivation it is usually common from May to October about old manure dumps, on lawns, in meadows and on the open prairie, growing abundantly on fairy rings. I have seen this king of mushrooms growing so abundantly on the Saline river north of Wa Keeney, on closely cropped buffalo grass, that I feel safe in saying that one day in June several years ago there could have been gathered a large farm wagonload from the tens of thousands of plants on a tract not to exceed five or six acres in extent.

Another species of this genus is *Agaricus arvensis,* the horse mushroom, which is quite similar to the meadow mushroom, but is much larger and coarser in structure, often reaching five inches in diameter. It is usually found about old barnyards and manure dumps It usually has a double collar around the stipe instead of single as in the case of the meadow mushroom. The pileus is thick and the gills are pinkish. The flavor is excellent.

Next we come to what are popularly known as the "ink caps," which belong to the genus *Coprinus* and are very fragile, and also of very short life, as they soon deliquesce and disintegrate in bright sunlight, melting to black masses. The species of this genus are all edible and of good flavor. The maned agaric, *Coprinus comatus,* is the best known and is readily recognized by its large, drooping cap, which never fully expands. The plant is four to six inches high, growing solitary or several together, in all sorts of situations. *Coprinus atramentarius* is found in dense tufts about old stumps and like situations. The campanulate pileus is thick and meaty, furnishing a good mass of toothsome food. *Coprinus ebulbosus* and *Coprinus micaceus* follow in order. They both grow in tufts about old stumps. The former has a scurfy pileus, while in the latter it is smooth but finely striate. A species closely related to *Coprinus* is *Panæolus.* The one species in this genus worthy of note is *Panæolus solidipes,* which is three to five inches high with a solid white stipe and bell-shaped, dirty-white pileus. It is of excellent quality and is often found in fair quantities on dung in pastures following a spell of rainy weather in July or August.

Two delicate and fine-flavored species which grow mostly in groups, found in groves and places where trees have been cut off, are *Hypholoma cutifractum* and *Hypholoma incertum.* They are very similar in appearance, with the exception that in the former the pileus is cutifractate or broken, while in the latter it is smooth and unbroken. The cap is white, inclining to purplish at the edges, thin and very brittle, one and a half to three inches in diameter, with a brittle white stipe of about the same length. It is common from June to August. To my taste there are no finer agarics than *Pholiota vermiflua* and *Pholiota præcox.* They are of a good size, with a thick, plane-expanded pileus

of two to three inches in diameter, on short stipe, cream-colored and viscid when young. The gills are grayish white at first, turning to a rich cinnamon brown with age. The plant often remains standing in the hot sun for several days after maturity, and becomes completely dry with but little change of form. The plants grow on cultivated ground about trees or out in the open field through May and June. In 1917, on a small tract of ground that had been sown to barley, where previously had been a plum orchard, the *Pholiota vermiflua* came up in May by the hundreds, and we were kept in fresh mushrooms every day as long as the conditions were favorable.

Cortinarius rimosus is another "best seller." Some seasons this species is found in great abundance, especially in cottonwood groves, where hundreds of them may be found in rows and curves entirely hidden beneath the old, dead leaves, which are raised up four or five inches, presenting the appearance of the runway of a mole as large as a rabbit! This fungus is of good size, two to four inches in diameter, with a grayish-white pileus of medium thickness, with light-bluish to purple-tinged gills. It grows singly or in groups of several plants united at the base. Several years ago I found this species so abundant in a cottonwood grove near our home that I brought in a buggyload every few days until the season for it had passed. Its edible qualities are close to the top of the list. *Lactarius velereus,* which in habitat is quite similar to the preceding species, is also a good edible mushroom, but usually not very abundant in this state. It is low and stocky, with thick stipe, white pileus, often depressed in the center. The flesh is quite peppery, which element passes off in cooking.

Pluteus cervinus, the deer mushroom, is a handsome edible species found in timber from May to August, on old logs, stumps and rotten wood. It is two to six inches high, with thin, very light fawn-colored pileus, two to four inches in diameter. It is common, but not abundant at any time.

The common oyster mushroom, *Pleurotus osteratus,* is found on old logs and stumps throughout the state wherever timber is grown, from June to September. It is nearly pure white throughout, sessile, and usually in laminated tufts eight to ten inches across. It must be collected when it is quite young to be of value, as it soon becomes tough and unpalatable It is a well-flavored species and easy of recognition, even to the novice, who having once learned its form is not likely ever to forget it.

What may well be called our winter mushroom is known scientifically as *Collybia velutipes.* I have found it on old logs, stumps and buried wood in every month of the year. It is light to dark yellow or tan color, with nearly white gills, and is usually found in dense groups with many of the pilei unexpanded. It is rather tough and does not come up in texture or flavor to many other species.

The last of the agarics of which I shall speak is *Lepiota morgani,* which is by far our largest species, and is found in all parts of the state from June to August. The plant is six to eight inches high and has a somewhat scaly pileus five to ten inches in diameter. The stipe is white and graceful, with a neatly laundered collar near the top. The gills or lamellæ are white, turning to light greenish with age. It occurs on prairies and in open woodlands. This is one of our unwholesome mushrooms and its use should be avoided. Nevertheless, it has a good flavor, and I have eaten it with relish, while one member of my

family was made quite sick from the same dish. Mycophagists everywhere, I believe, give it just these properties—making certain persons quite ill while others go unharmed.

Let us now turn to the puffballs. Of these, the giant puffball, *Calvatia gigantea,* is the largest and best known as it often measures twelve to eighteen inches in diameter. It is nearly smooth. It is common throughout the state and should all persons know of its esculent qualities thousands of pounds of palatable and nutritious food might be utilized which now goes to waste. This species dries to a rich brown when the spore mass breaks. The flavor is quite excellent when the plant is young, but becomes much stronger with age. *Calvatia cœlata* is another of the large puffballs with a beautifully embellished, warty top, quite unlike the preceding species. It also in breaking reveals a dense brown spore mass. Its flavor and edible qualities are similar to the giant puffball, for which it is often mistaken. Coming down the scale a little, we have two more rather large puffballs, viz., *Calvatia cyathiformis* and *Calvatia lilacina.* Both species are found in open glades and on the prairies in all parts of the state. They are readily separated from the previously mentioned species by the deep purple spore masses manifest in the ripe fungus, and by their more attractive flavor when served. The aforementioned four species constitute, perhaps, nine-tenths of the edible puffball flora of Kansas. Then come the little puffballs, such as *Lycoperdon pulcherrimum,* the beautiful, covered all over with white, bristly excrescences, *L atropurpureum, L. wrightii,* and many others. As there are no poisonous puffballs, you are at liberty to help yourself to anything you may find. There are, however, several species which carry a rather disagreeable odor, which should be discarded as undesirable.

Last, but not least, we come to the morels, or sponge mushrooms, of which species *Morchella esculenta* is the most common and best known. It is of a dull flesh color, usually conical, deeply pitted in its fruiting parts, and rests on a thick, hollow white stipe. This species, while common throughout the United States and Canada, is seldom abundant, but when you do find it in sufficient quantity for table use, if rightly prepared, you have a dish fit for a king.

My object in this paper, is, if possible, to draw your attention to the fascinating conservation of tens of thousands of pounds of most delicious food which annually goes to waste through a lack of knowledge in knowing how to properly care for it. As to the actual food value of mushrooms the authorities differ. Some claim that of the better varieties, pound for pound, they are equal to beefsteak, while others claim that the food value is very little above that of turnips or cabbage, and that a chemical analysis discloses but a very meager food content. To the latter class belong that large company of persons who are not mushroom eaters or mycophagists. The constituent elements which are contained in the ordinary mushroom are not easy of analysis as to their intrinsic and nutritive value as a food product. Let us look at the matter from the analytical chemist's standpoint. He can take a pound of beefsteak to his laboratory and analyze it carefully, giving us in hundredths each and every constituent element contained therein, and by adding up these elements as indicated on his trial paper will give us within a fraction the round 100 per cent. Yet should he go to his shelves and from his containers take the exact

amount of each element, as per analysis, and place them in a bowl and thoroughly mix, what would he have? Verily, not beefsteak; but rather would he have a dirty-looking, sloppy mass that would most probably cause a well-bred dog to put his tail between his legs and hike for a hole under the barn! Often, on "a hungry summer day," as Will Carleton says in his "Lightning Rod Dispenser," I have eaten a full meal of mushrooms with scarcely a mouthful of other food, and their staying qualities have always been as satisfactory as a full meal of bread, potatoes and meat. With me, mushrooms as a food and a relish are par excellence!

It would be foolish to contend that the medicine which the sick man takes contains food elements which restore him to his normal health, for we know that all medicines are given for the sole purpose of assisting nature to assume its functions by throwing off the disaffection. You are at liberty here to follow out the sequence.

By the brief descriptions given in this paper you will not be able to determine all the species named, so you want to know, then, how it may be done. Good! This is a rather hard proposition to set before you with any positive clearness. This knowledge must mainly be attained in the field, but it will not come down upon you like "a rushing, mighty wind," as the Spirit descended on the day of Pentecost, but rather it will take months, and perhaps years, for a fair development. Knowing the difference between a puffball and an agaric, you desire to know how to distinguish between the different species in each of these groups. The printed descriptions in the books, the big out-of-doors and the association of some one who *knows* should soon place your feet in the path to a good attainment.

You recognize your friend by his form and features; you know the difference in appearance between the figure 6 and the figure 7; the face of your friend is unlike that of any one else among your acquaintances; the figures 6 and 7 are wholly unlike and you never confound one with the other. This is the secret of the whole matter. Get on speaking terms with your fungus friends and the door of attainment will swing open before you, never to close.

The methods of preparing mushrooms for the table are various indeed, and for the best results should conform to the taste and practice of the eater. In Farm Bulletin No. 796 of the U. S. Department of Agriculture many methods of preparation are given. The canning of all sorts of mushrooms is becoming a common and most valuable practice, a full account of which is given in the bulletin also. Aside from some of the more æsthetic forms of mushroom cookery is the common, inexpensive stew, which applies to nearly all forms alike, and is as follows: Place the prepared material in a porcelain or granite stewer, with sufficient water, and boil for ten to twenty minutes, according to the texture of your mushrooms. Remove from the fire, pour off the water, replace on the fire and pour in sufficient rich, sweet milk to nearly cover the mushrooms; then season to taste with butter, pepper and salt, and let the mass again just come to a boil. Serve hot, and you will have a dish to a queen's taste.

There is a pronounced prejudice against the eating of mushrooms. Many people are afraid to have anything whatever to do with them. Guests at our own table have looked askance and with astonishment upon us as we partook of the "vile stuff," with a look on their faces as though they expected to see us

in the throes of mortal agony at any moment, which always puts us in remembrance of the barbarians who thought the same thing of the Apostle Paul on the island of Melita when the viper fastened itself on his hand. It is true that many cases of fatal mushroom poisoning, through ignorance or carelessness, have occurred from the Missouri river east to the Atlantic coast, but when the good Lord staked out the territory of Kansas it pleased Him to hedge it about with such peculiar conditions that we are almost if not entirely free from poisonous species. The deadly amanitas do not seem to be a product of Kansas, as we have no published reports of their occurance in the state. *Amanita phalloides* and *A. muscaria* of the East cause, perhaps, nine-tenths of all the fatal cases of mushroom poisoning in the United States.

There is, however, one species of this genus, *Amanita prairiicola,* in western Kansas, growing in short buffalo grass on the high prairies of Phillips and Rooks counties, in August and September. The writer discovered this species in August, 1896. It is white throughout, with medium length stipe, scurfy pileus and dries solid in situ. It has a villainous appearance, and I have given it a rather wide berth. It was described by Dr. Chas H. Peck in Bulletin Torrey Botanical Club, p. 138; 1897.

What are known as unwholesome mushrooms, such as *Lepiota morgani,* cause a very unpleasant illness very soon after being eaten, but the deadly species do not show their effects for a number of hours, or perhaps until the following day, when their action is violent and positive, leaving the patient in no doubt as to his misfortune.

No, there is no "discolored silver spoon" test or any other chemical method to distinguish between a poisonous and a nonpoisonous mushroom.

More Evidence That Platte River, Nebraska, Formerly Connected with Grand River, Missouri.

JAMES E TODD

As it is uncertain whether this investigation may be carried further very soon, it seems well to place on record a report of progress to date.

In preparing a paper on the Pleistocene history of the Missouri river (Science, n. s, vol xxxix, p. 263 *et seq.*), in examining the topography of the country it was found that the steepest slope from a point near Nebraska City on the Missouri river was not along the course of the Missouri, but southeast to the vicinity of Stanberry, on Grand river, Missouri. Attention was called to the fact, and the theory was proposed that preceding the Kansan stage of the great-glacier the drainage was southeastward rather than along the line of the present Missouri.

Another fact was recalled that in the preparation of Bulletin 158 of the United States Geological Survey, reference had been made to the report of the United States engineers for 1890, which stated that a deep preglacial channel had been discovered near Nebraska City. As no other similar case was found at the time of publication of said Bulletin 158, it was judged more probable that some Pennsylvanian strata had been mistaken for till and glacial gravels.

With a map of the region in hand, it will be noticed that there is a branch of the Grand river rising near Platte river, Missouri, and flowing southeast.

There had been reported from Stanberry the existence of a deep, buried channel. The supply of water for that city is derived from wells 200 feet deep, the water rising very nearly to the surface. Near Clyde, a few miles northwest, a small flowing well was found, said to be 300 feet deep. Not far away, on higher ground, another well had pierced the same supply.

At Tarkio, Mo., on the Big Tarkio river, several artesian wells were made several years ago. These are quite fully reported in "The Underground Waters of Missouri," Water Supply Paper 195, United States Geological Survey. One of the first was at the electric-light plant, a little west of the main valley of the river, and on slightly higher ground.

	Thickness, feet	*Depth feet*
Black loam	30	30
Gray clay, with strata of glacial bowlders	40	70
Blue clay	100	170
Hardpan	10	180
Coarse sand	10	190
Rock	20	210

Professor Adair, of Tarkio College, mapped some fifteen or sixteen flowing wells which extend up and down the Tarkio valley for five or six miles. Most of these derive their supply from the gravel below the bowlder clay, there being about the same sort of formations in all the wells, excepting some toward the south, which furnish salty water, evidently from the Pennsylvanian. In most of the wells there are two water supplies—one, which is quite soft, 30 or 40 feet below the surface, in the valley; another, the most abundant supply, from about 170 feet, is hard. The latter is from sand and gravel, below thick, blue till.

Professor Adair and Professor Sheperd, who prepared the water-supply paper, both attributed the gravel and sand to a preglacial channel of the Big Tarkio, but Mr. James Chambers, who has bored many wells in that region, is strongly of the belief that the preglacial channel in which the gravel was laid extends from the northwest to the southeast. He claims that the gravel, with abundant water, has been struck in wells nineteen miles northwest and about twenty miles southeast of Tarkio. His idea is that the ancient valley was about four miles in width. The well which Mr. Chambers drilled farthest northwest from Tarkio was about nine miles southeast of Hamburg, Iowa.

Returning to Nebraska City, we find in the report of Mr. E. H. Wilson, December 1, 1879, quite a discussion of the various sections near Nebraska City, in which he speaks of the preglacial channel as being from 165 to 175 feet below the present surface of the bottom lands and 60 to 75 feet deeper than the rock-worn bed of the old Missouri. He says that "the deeper valley was largely filled with a very hard, tenacious, drab-colored clay, mixed with angular fragements of stone, generally of lime, though in one observed instance, of quartzite, the prevailing bowlder material of the northern glaciers." The general direction of the deep channel, he says, was south 80 degrees east, nearly at right angles with the main direction of the Missouri. He suggests that it may be an old bed of the Platte river in Nebraska, and mentions the abrupt turn of the Platte eastward about 20 miles above its mouth as suggestive. He apparently thought of the eastern turn as a change resulting from the glacial period. He was impressed, also, with the absence of limestone cliffs in the line of the deep valley.

A consideration of a map of the region suggests that a branch of the Weeping Water from the northwest might indicate or result from an old channel of the Platte; but from a personal knowledge of the exposures along both the Weeping Water and the Platte, which are nearly continuous in both cases, his view seems entirely improbable. It seems more probable that the deep channel lay more nearly along the present course of the Platte and the Missouri river. The borings in the vicinity of Plattsmouth, reported in the annual report of the Missouri River Commission for 1890, does not reveal any trace of the deep channel, from the simple fact that they had no means of penetrating the river deposits below a depth of about 80 feet An examination of the junction of the Platte and the Missouri simply shows that over much of the area bedrock was below a depth of 80 feet; how much we have no means of knowing. Hence there is nothing to forbid the conclusion that Platte river of Nebraska probably flowed down the present valley of the Missouri.

In order to get some idea of the slope of the preglacial river we have had difficulty in finding any definite level to figure on. The upper limit of main gravel and sand, we may expect in many cases, was much reduced by the action of the glacier, while in other localities it may have been unaffected by those agents. The bottom of the gravel would doubtless vary much according to the hardness of the bedrock below, hence would not furnish a very reliable guide On the whole, however, the latter seems the best to take for our purpose. At Nebraska City the bottom of the ancient channel is about 170 feet below the surface of the bottom land, which at Payne, opposite Nebraska City, is 924 feet A. T., which would make the bottom of the deep channel at that point about 755 feet. At Tarkio the city well, with its top 950 A. T., struck bedrock at a depth of 190 feet, or at an altitude of 753 feet. The bottom of the sand is lower toward the south, and quite possibly toward the east. Near Clyde, whose altitude is judged to be about 931, bedrock is said to have been struck about 300 feet in depth, but both the altitude of Clyde and the depth for the striking of bedrock in the well are not very reliably reported At Stanberry bedrock is struck 200 feet below the level of the station, which is 850 A. T

Putting these data together, we find that from Nebraska City to Tarkio the slope is only about one-third of an inch to the mile, but from Nebraska City to Stanberry the slope is about one and one-third feet per mile. This is a little more than that of the present Missouri from Nebraska City to Kansas City.

The absence of prominent exposures of limestone along the general course of this supposed Platte-Grand valley indicates that a master stream had cut down nearly to grade and had a bottom land three or four miles wide.

From its position and direction we should expect that it might receive tributaries both from the southwest and northeast. In studying the map of the Missouri river trough we find that opposite Plattsmouth, Neb., the bottom land is about six miles wide, at Nebraska City seven and a half, while the ordinary width is less than four miles; at Amazonia it is only about three. Two other wide places in the valley are found opposite the mouths of the tributaries of the Missouri from the west. One is opposite the Little Nemaha, where it is nine miles in width; another opposite the Big Nemaha, where it

is fully twelve miles in width. It seems probable that the latter-mentioned streams formerly flowed through to the master stream of the valley near Stanberry. At Falls City, Neb., on the Big Nemaha, there is a terrace about forty feet above the level of the stream composed mainly of older rocks, capped with a few feet of gravel, which is mostly chert. This material is observed along other streams in Kansas as marking the bottom of preglacial streams. Taking the slope from Falls City to Stanberry, it is found to be about five and one-third feet per mile.

While the facts just considered seem to favor the theory as presented, there are some facts which do not readily harmonize. One is the fact that the pressure in artesian wells at Tarkio cannot be from a higher portion of the main channel, because they are about on the same level with the bottom lands near Nebraska City, so that the water appearing at Tarkio cannot be supplied from the main channel of the Missouri, as we might expect. It seems probable that the water in the Tarkio wells is supplied by an old channel or tributary coming in from the north along the line of the Big Tarkio.

Moreover, the slope of the valley from Nebraska City to Tarkio seems insufficient, but we should remember that we are trying to judge of the slope of the stream from the altitude of the bedrock on the bottom, which may vary from being parallel with the surface of the stream at least thirty or forty feet.

It should be mentioned that at Atchison there is distinct trace of an old channel running toward the northeast and showing several feet of chert gravel about seventy feet higher than the Missouri river. That would indicate that it was probably another tributary of the Platte-Grand river, which is at that altitude because of the divide of the master stream northeast and the Kansas river to the south.

While the tracing of this ancient channel is more of educational than of economic importance, it may eventually lead to the discovery of an important water supply.

The Eleodes of Riley County, Kansas.[1]

JAMES W. McCOLLOCH

The increasing economic importance of many species of the genus *Eleodes* Eschscholtz has necessitated a careful study of the distribution of the members of this group. The beetles of this genus are native insects confined principally to the semiarid regions of North America. Wickham[2] has recorded three species—*tricostata, opaca* and *suturalis*—from Iowa, and these are the only species reported east of the ninety-eighth meridian. The natural habitat of the various members of the genus is the native prairies or sagebrush areas. The gradual reduction of these areas is depriving these insects of their natural food and forcing them to feed on the more succulent crops. Several species have become adapted to the new conditions and are now recognized as important pests of cultivated crops.

1. Contribution No. 46, from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Experiment Station.

2. Wickham, H. F.; 1899. Eleodes in Iowa: Proc. Iowa Acad. Sci. 7:59, 60.

In 1915 the department of entomology of the Kansas Agricultural Experiment Station began a thorough study of the species of *Eleodes* occurring in Kansas. In connection with this work limited collections have been made in various localities in the state when opportunity afforded, and extensive collections have been made in Riley county. During the four years that these studies have been in progress four species and one variety of *Eleodes* have been found in Riley county. Certain peculiarities in habitats, relative abundance and activities, bearing on ecological relationships, have been noted, and it seems advisable to publish this short list of species.

Eleodes tricostata Say.

Tricostata is the predominating species in Riley county, constituting over 95 per cent of the total collections of *Eleodes* during the past four years. It is typical of the high prairies of this region, rarely being found in other situations. Of the 1,598 beetles collected last year, 1,587 were taken on the uplands, ten on what might be called second bottom, and one was found running about on a sand beach along the Kansas river.

During the day the beetles are found hiding under rocks, logs and cow chips. As high as thirty-two beetles have been found under a single small rock. In the collections of the past four years the males have predominated, representing 61 per cent of the number collected. The period of activity is from June to October. While the winter is usually passed as a larva, some adults also hibernate, a few having been found early each spring

Eleodes opaca Say

Opaca, which is the most injurious species occurring in the state, is only occasionally taken in Riley county. During the years 1916, 1917 and 1918, 303 beetles of this species were collected All but two of these were collected on the high prairies, where they were usually associated with *tricostata.* In one instance two females were found in an alfalfa field on lowland. The females have predominated in the collections, representing 56 per cent of the total number. The period of activity is from June to September.

Eleodes suturalis Say.

This species is rare in this locality, only a few specimens being taken each year. Nine beetles were collected in 1917 and 1918, six of which were females. In addition, the collection of the Agricultural College contains about fifteen specimens from the area under consideration With one exception, all the specimens studied were from the high prairies. This species is usually found during the day, hiding under rocks and logs. The period of activity is from June to September. In one case, however, the writer collected a female April 17, 1916, indicating that this species may pass the winter as an adult as well as in the larval stage.

Eleodes hispilabris Say.

Hispilabris is exceptionally rare in this locality, and thus far has been taken only in the sand-dune area along the Kansas river four miles south of Manhattan. The writer collected two males of this species on July 23, 1918, and one female was reared from a larva collected April 9, 1918. One of the males was found under a cow chip and the other was running on the bare sand. The collection of the Agricultural College also contains two specimens taken in the same area. One was found running on the ground, July 26, 1902, and the other was obtained in general collecting, June 24, 1903. From the meager data at hand, the period of activity appears to be June and July. *Hispilabris* has probably been introduced into this area in drift carried by high water on the Kansas river.

Eleodes suturalis var. *texana* Le Conte.

This variety is rare in Riley county, and thus far the writer has not taken it. There are two specimens, however, in the collection of the Agricultural College collected on the hills about Manhattan.

The Lachnosterna of the Vicinity of Manhattan, Kan.[1]

JAMES W MCCOLLOCH and WM P HAYES

The genus *Lachnosterna* Hope offers an excellent field for a study of almost any phase of investigation of insect bionomics. Composed of approximately 235 species distributed over the Western hemisphere, one need not lack for material. The economic entomologist has been interested in this group for many years, and to-day a vast amount of work is being done with regard to economic studies. As pointed out by Glasgow (1916), the distribution of the species is an important subject, since it offers a basis for the study of problems relating to the origin and source, the diversification and the dispersal of animal forms in North America

SOURCE OF DATA.

The following local list of *Lachnosterna* is based primarily on 41,633 specimens collected by the writers during the years 1916, 1917 and 1918. The work has been done in connection with an investigation on the biology of *Lachnosterna of* Kansas, which is one phase of studies on insects injurious to the roots of staple crops being made at this station. In addition, use has been made of the collection of the department of entomology, which contains approximately 2,000 pinned specimens, and reference has been made to the literature on distribution relative to the area under discussion.

ACKNOWLEDGMENTS.

The writers are under many obligations to Mr. J J. Davis, of the Federal Bureau of Entomology, for the identification of many specimens and for his kindness in supplying the College collection with a large series of beetles The determination of the rarer species have been made by Mr. Davis, or verified by him. Mr. Warren Knaus has at all times been ready to supply the writers with information concerning the various species, and has kindly identified some of the material.

IMPORTANCE OF THE GENUS.

The various species of *Lachnosterna* have long been recognized as among the most serious pests of crops The larvæ, or white grubs, are subterranean in their habits, feeding on the roots of cultivated crops and grasses. Corn and timothy seem to suffer the greatest injury, but within recent years considerable injury has been noted in the fields of small grains. Nursery plantings and strawberry beds are often devastated, and in the Northern states the grubs have been particularly bad in beds of conifer seedlings.

The adults feed almost entirely on the foliage of trees, small fruits and shrubs, the amount of injury varying with the seasons and with the number of beetles present. Davis (1916, p. 270) reports the almost total defoliation of the timber over large sections of Illinois, Iowa, Wisconsin and Michigan in

1. Contribution No 45, from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Experiment Station.

[NOTE.—Glasgow (1916) placed the generic name *Lachnosterna* in synonomy and re-established the name *Phyllophaga*, proposed by Harris. At the time this paper was written (1918) there was some controversy as to whether this change would be adopted (see Review Applied Ento., 5:63), and it was felt that *Lachnosterna* should stand, since it was so well known even among the laity. Later studies, however, indicate that *Lachnosterna* should revert to synonomy and *Phillophaga* be retained.—Feb. 10, 1922.]

1914. To illustrate the number of beetles present during that year, he states that "at one small town in Wisconsin the beetles accumulating beneath the ten arc lights of the town were hauled away each morning, for a period of ten days or two weeks, by the wagonload."

FACTORS CONTROLLING DISTRIBUTION.

The distribution of animals is usually considered from a static or from a dynamic standpoint. Often both are considered, and there is frequently an overlapping of the two The static viewpoint attempts to correlate the distribution with various arbitrarily chosen standards, as temperature, natural barriers, etc., which are subdivided into areas or zones. The dynamic viewpoint explains distribution in terms of the relation of the animals to their complete environmental complex. Within recent years this method has superseded the former. The study of animal distribution may be taken up from many sides and in many ways, and probably the most fundamental of these considers the dependence of the animal on its environment.

Forbes was one of the first to recognize the importance of a thorough study of the May beetles in relation to their environmental complex, and he has done much along this line. He states (1907, p. 447) that "for a practical knowledge of these destructive insects it is necessary that we should know the various species of them which do serious injury to agricultural and to horticultural crops, the life histories of all these species; their relative numbers in different parts of the state in different years and in different periods of years their food, both as grubs and as adult beetles, including their common preferences where several kinds of food are available to them, their significant habits, especially those of reproduction; their relations to variety of weather and to seasonal change, their modes, times and places of hibernation; the range of their daily movements and of their movements of migration and dispersal, their enemies, their diseases, especially those of a contagious character, and other natural checks on their multiplication; their relation to varieties of soil, to its physical condition, its moisture and its exposure to the sun; their relation to varieties of the subsoil also; the effects on their continuance and increase of various agricultural operations and kinds of farm management; and their own effects, under varying conditions, on the several kinds of crops subject to injury by them."

Davis (1916) began a study of the May beetles in 1911 with the idea of working out the life history of every species available. He is also working out the distribution of the species in all parts of the country in relation to soil, timber, farming methods and other environmental conditions.

There are a number of factors entering into the environmental complex, of which latitude, altitude, temperature, moisture, food and soil are probably the most important. These factors do not act separately, but there is an overlapping, *e. g.*, latitude and altitude are closely correlated with temperature, and possibly moisture, and these are operative on the food plants as well as on the insects. Davis (1916, p. 268) says that there are at least three factors limiting the distribution of the different species of *Lachnosterna,* namely, soil, trees, and elevation.

METHODS OF DISTRIBUTION.

Distribution of migration occurs principally in the adult stage, since the grubs are subterranean in their habits, are very sluggish, and are not capable

of rapid locomotion. They change their location only when forced to by the exhaustion of the food supply. The beetles, on the other hand, feed principally on the foliage of trees. They are nocturnal in their habits, flying back to the fields at the approach of dawn. From the data at hand it is apparent that migration occurs during the adult stage, and may be by flight, winds, storms and floods.

GENERAL DISTRIBUTION.

The genus *Lachnosterna,* composed of approximately 232 species (Dalla Torre, 1912), is confined almost entirely to the Western Hemisphere, extending from the Hudson bay territory to Argentina. The largest number of species are known from the United States, due probably to the fact that more systematic collecting has been done in this country. According to Glasgow (1916) this genus is represented in the United States by 97 species. In some cases the distribution is fairly well established, and while many collections have been made in various localities, it is still necessary for more extensive work to be done. Davis (1916), Forbes (1916), and Sanders and Fracker (1916) have shown that there may be a great variation in the number and abundance of the species present within a rather limited area. In order that the complete distribution of each species may be worked out for the United States collections should be made in many localities in each state. These collections should cover a period of years and should be made at lights, on food plants and from the soil.

In so far as the writers have been able to determine, no systematic collections of *Lachnosterna* have been made in Kansas. The museums of the Agricultural College and the University of Kansas contain many specimens, but in most cases the accompanying data are too meager to determine the relative abundance and habits of the species. Several papers have been published in the Transactions of this Academy, notably Popenoe (1877) and Knaus (1898), which contain lists of the *Lachnosterna* of the state. In addition, Knaus (1897) published on the *Lachnosterna* of Kansas, in which he listed 47 species and varieties, together with a few notes on the distribution, abundance and period of activity.

DISCUSSION OF THE *LACHNOSTERNA* OF RILEY COUNTY, KANSAS.

In the present paper the writers have attempted to bring together all the available records relative to the presence of *Lachnosterna* in Riley county. An annotated list of species is presented, together with certain notes on relative abundance, period of flight, and food. As the work progresses it is planned to enlarge this phase of the work to include the entire state. The present list represents twenty-three species, obtained in a collection of 41,633 specimens made by the writers and six species represented in the collection of the Agricultural College, or reported in the literature.

ANNOTATED LIST OF LACHNOSTERNA OF RILEY COUNTY.

SPECIES IN THE COLLECTION OF THE WRITERS.

Lachnosterna lanceolata Say.

1824. *Melolontha lanceolata* Say, Journ. Acad. Nat. Sci. Phila. III, p. 242; LeConte, Ed. 1869, II, p. 142.
1850. *Tostegoptera lanceolata* Blanchard, Cat. of Coll. Ent. I, p. 149.
1855. *Tostegoptera lanceolata* Burmeister, Handb. Ent. IV, p. 356.

1856. *Ancylonycha lanceolata* Lacordaire, Gen. Coll. III, p. 285.
1856. *Lachnosterna lanceolata* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 237.
1887 *Lachnosterna lanceolata* Horn, Trans. Amer Ent. Soc. XIV, p. 216
1889. *Lachnosterna lanceolata* Smith, Proc. U. S. Nat Mus. XI, p. 493.
1916. *Phyllophaga lanceolata* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

One of the most common species, being especially abundant on the high prairies. During the past three years 11,300 beetles, or 27 per cent of the total collections, have been made of this species.

Lanceolata differs from most of the members of this genus in that the adults are active during the day, the females are wingless, and pupation occurs early in the spring.

Collections: On food plants and flying, 11,299; in soil, 1; total, 11,300.

Period of flight: June 11 to July 30.

Principal food plants:[2] Ironweed, evening primrose, clover.

Incidental food plants: Pepper grass, shoestring plant, bladder ketmia, vervain, false boneset, hoary aster, milfoil, little ragweed, thistle, little blue stem, *Liatris*, big blue stem, Sampson's snakeroot, goldenrod, crab grass, sunflower, pigweed, sumach, bindweed, venus' looking-glass, corn, oats, cocklebur.

Additional notes: The collection of the Agricultural College contains a large series of beetles taken on weeds and trees in June, 1902.

Lachnosterna prætermissa Horn.

1887 *Lachnosterna prætermissa* Horn, Trans Amer Ent. Soc XIV, p 223
1889 *Lachnosterna prætermissa* Smith, Proc U S Nat Mus XI, p 495
1889 *Lachnosterna definita* Smith, Proc. U S Nat. Mus XI, p 501
1916 *Phyllophaga prætermissa* Glasgow, Bull Ill State Lab Nat Hist XI, p 373
1916. *Phyllophaga definita* Glasgow, Bull Ill State Lab. Nat Hist. XI, p 373.

This species is rare in Riley county and hitherto has not been recorded from the state. A few specimens were taken in 1917 and 1918.

Collections At lights, 7; total, 7.

Period of flight May 16 to June 11

Lachnosterna longitarsa Say.

1824 *Melolontha longitarsa* Say, Journ Acad. Sci. Phila. III, p 241.
1856. *Lachnosterna longitarsa* LeConte, Journ. Acad Nat. Sci. Phila. (2) III, p. 240.
1887 *Lachnosterna longitarsa* Horn, Trans Amer. Ent Soc XIV, p. 226
1889. *Lachnosterna longitarsa* Smith, Proc U S Nat. Mus. XI, p 496
1916 *Phyllophaga longitarsa* Glasgow, Bull Ill State Lab. Nat Hist XI, p 371.

A rare species in this locality, appearing late in the season, about 73 per cent of the collection has been females.

Collections: At lights, 78; on food plants, 1, in soil, 1; total, 80.

Period of flight: June 25 to August 2.

Food plants: One male was taken on elm in 1917.

Lachnosterna futilis LeConte.

1850. *Lachnosterna futilis* LeConte, Lake Superior, Its Phys. Char Veg. and Animals (Agassiz), p. 226
1855. *Ancylonycha gibbosa* Burmeister, Handb. Ent. IV, 2, p 324
1856 *Lachnosterna futilis* LeConte, Journ. Acad. Nat. Sci Phila. (2) III, p. 243.
1856. *Lachnosterna decidua* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 246.
1856. *Lachnosterna serricornis* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 247.
1873. *Lachnosterna futilis* LeConte, Proc. Acad. Nat. Sci. Phila. XXV, p. 330.
1887. *Lachnosterna gibbosa* Horn, Trans. Amer. Ent. Soc. XIV, p. 230
1889. *Lachnosterna gibbosa* Smith, Proc. U. S. Nat. Mus. XI, p. 497.
1916. *Phyllophaga futilis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p 371.
1916. *Phyllophaga gibbosa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
1916. *Phyllophaga decidua* Glasgow, Bull Ill. State Lab Nat Hist XI, p. 371.
1916. *Phyllophaga serricornis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

Futilis ranks fourth in the number of beetles taken in the past three years, comprising 11 per cent of the collections. Of these, 93 per cent were collected

2. The food plants in all cases are listed in the order of the apparent preference as shown by the number of beetles collected.

at lights. In the collection from food plants the proportion of sexes has been about equal, while in the collections at lights over 90 per cent have been males. *Futilis* has a rather wide range of food plants, having been taken on 23 different plants.

Collections: At lights, 4,455; on food plants, 330; in soil, 5; total, 4,790.

Period of flight April 18 to July 21

Principal food plants Hackberry, hawthorne, horse chestnut, linden, elm, locust.

Incidental food plants Birch, cherry, Norway maple, spirea, coffee tree, oak, box elder, ash, plum, rose, mulberry, silver poplar, sumac, catalpa, apple.

Additional notes The Agricultural College collection contains one specimen found feeding on *Ceanothus ovatus*, May 23, 1889, and one specimen taken on willow, May 22, 1889.

Lachnosterna congrua LeConte.

1856 *Lachnosterna congrua* LeConte, Journ Acad Nat Sci Phila (2) III, p 243
1873 *Lachnosterna congrua* LeConte, Proc Acad Nat Sci Phila. XXV, p 330
1887. *Lachnosterna congrua* Horn, Trans Amer Ent Soc XIV, p 232
1889 *Lachnosterna congrua* Smith, Proc U S Nat Mus XI, p 498
1916. *Phyllophaga congrua* Glasgow, Bull Ill State Lab Nat Hist XI, p 372

This species is rare, having been taken in small numbers in 1917 and 1918 The collections thus far made contain only males

Collections At lights, 28, on food plants, 1; total, 29

Period of flight May 16 to June 10

Food plant Hackberry.

Lachnosterna crassissima Blanchard

1850 *Ancylonycha crassissima* Blanchard, Cat Coll Ent Mus Nat Hist de Paris I, p 133
1856 *Lachnosterna obesa* LeConte, Journ Acad Nat Sci Phila (2) III, p 251
1856 *Lachnosterna robusta* LeConte, Journ Acad Nat Sci. Phila (2) III, p 257
1873 *Lachnosterna obesa* L Conte, Proc Acad Nat Sci Phila XXV, p 330
1875. *Lachnosterna robusta* Horn, Trans Amer Ent Soc V, p 143
1887 *Lachnosterna generosa* Horn, Trans Amer Ent Soc XIV, p 222
1887 *Lachnosterna crassissima* Horn, Trans Amer Ent Soc XIV, p 230
1889 *Lachnosterna generosa* Smith, Proc U S Nat Mus XI, p 495
1889. *Lachnosterna crassissima* Smith, Proc U S Nat Mus XI, p 499
1916 *Phyllophaga crassissima* Glasgow, Bull. Ill State Lab. Nat Hist XI, p 372.
1916 *Phyllophaga obesa* Glasgow, Bull Ill State Lab Nat Hist XI, p. 372
1916 *Phyllophaga robusta* Glasgow, Bull Ill State Lab Nat Hist XI, p 372
1916. *Phyllophaga generosa* Glasgow, Bull Ill State Lab Nat Hist XI, p 372

Crassissima is the predominating species in the area under consideration. During the past three years 14,510 specimens, or 35 per cent of the total collections, have been of this species. In the work thus far conducted over 99 per cent of the beetles have been taken at lights While regular collections have been made on about forty species of plants, very few beetles have been found on the plants under observation Schwarz (1891) says this species probably feeds on grass or low herbage. The males greatly predominate in the collections made at lights, comprising 78 per cent of the beetles taken

Collections At lights, 14,406; on food plants, 65; in soil, 39; total, 14,510

Period of flight April 23 to August 17.

Food plants: Strawberry, elm, oak, catalpa, apple, linden, locust, birch, hackberry, dock, hawthorne, box elder, horse chestnut, ash.

Lachnosterna inversa Horn

1887. *Lachnosterna inversa* Horn, Trans Amer Ent Soc XIV, p. 241
1889. *Lachnosterna inversa* Smith, Proc U S. Nat Mus XI, p 500
1916. *Phyllophaga inversa* Glasgow, Bull. Ill State Lab. Nat. Hist. XI, p 373.

Exceptionally rare in this locality, being taken only in 1917.

Collections: At lights, 4; total, 4.

Period of flight: May 26 to June 17.

Lachnosterna bipartita Horn.

1887. *Lachnosterna bipartita* Horn, Trans Amer Ent Soc. XIV, p. 242.
1889 *Lachnosterna bipartita* Smith, Proc U S Nat. Mus XI, p 500
1916 *Phyllophaga bipartita* Glasgow, Bull. Ill State Lab Nat Hist. XI, p. 373

Bipartita has been relatively common in the collections at lights during the past three years It is of interest to note, however, that only six females were found. The collections from trees have contained few specimens of the species.

Collections At lights, 570, on food plants, 8; in soil, 8; total, 586

Period of flight May 14 to July 8

Food plants Willow, apple, locust, birch, peach.

Lachnosterna vehemens Horn.

1887 *Lachnosterna vehemens* Horn, Trans Amer Ent Soc XIV, p 244.
1889 *Lachnosterna vehemens* Smith, Proc U S Nat Mus XI, p 501
1916 *Phyllophaga vehemens* Glasgow, Bull Ill State Lab Nat Hist XI, p 373

Vehemens was fairly numerous in this locality in 1916 and 1917. It is one of the first species to appear in the spring The collections thus far are very indefinite as to the food of these beetles.

Collections At lights, 422; on food plants, 6; total, 428.

Period of flight· April 18 to June 23.

Food plants Hawthorne, horse chestnut, hackberry

Additional notes. The Agricultural College collection contains four specimens taken on plum May 9, 1892.

Lachnosterna fervida Fabricius.

1775 *Melolontha fervida* Fabricius, Species Insectorum, Tomus I, p. 36
1801. *Melolontha quercina* Knoch, Neue Beyt zur Insect, Theile I, p 74
1855. *Ancylonycha fervida* Burmeister, Handb Ent IV, 2, p. 339.
1888 *Lachnosterna arcuata* Smith, Insect Life I, p 183
1889 *Lachnosterna arcuata* Smith, Proc U S Nat Mus XI, p 503
1916 *Phyllophaga fervida* Glasgow, Bull Ill State Lab Nat Hist XI, p 370
1916 *Phyllophaga quercina* Glasgow, Bull Ill State Lab Nat Hist XI, p 370
1916 *Phyllophaga arcuata* Glasgow, Bull Ill State Lab Nat Hist XI, p 370.

This species is represented in the collections by seven males taken in 1917.

Collections. At lights, 7; total, 7.

Period of flight May 30 to June 23.

Lachnosterna fusca Froelich.

1799 *Melolontha fusca* Froelich, Der Naturforscher, Stueck 26, p 99, and Stueck 29 (1802), p 113
1817. *Melolontha fervens* Gyllenhal, Schon. Syn Ins I, 3, p 171, appendix, p. 74.
1837 *Rhizotrogus fervens* Kirby, Fauna Bor. Amer IV, p. 132
1850 *Ancylonycha fusca* Blanchard, Cat Coll Ent Mus Nat Hist de Paris I, p 133
1856 *Lachnosterna fusca* LeConte, Journ. Acad Nat. Sci Phila. (2) III, p. 244.
1861 *Lachnosterna fusca* Candeze, Mem Soc Sci Liege XVI, p 347
1884. *Lachnosterna fusca* Casey, Contrib. Col. N. Amer, p. 38.
1887 *Lachnosterna fusca* Horn, Trans. Amer. Ent. Soc. XIV, p. 245
1889 *Lachnosterna fusca* Smith, Proc U. S Nat Mus. XI, p. 505
1916. *Phyllophaga fusca* Glasgow, Bull. Ill. State Lab. Nat. Hist XI, p. 371.
1916. *Phyllophaga fervens* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

This species is not common to Riley county, and with the exception of 1917 has been exceptionally rare. Practically all of the specimens have been taken at lights.

Collections: At lights, 58; on food plants, 2; total, 60.

Period of flight: April 22 to June 17.

Food plants: Oak, linden.

Additional notes: The Agricultural College collection contains the following specimens: One at the roots of horse radish, April 15, 1889; two feeding on plum trees, April 28, 1889.

Lachnosterna corrosa LeConte.

1856. *Lachnosterna corrosa* LeConte, Journ Acad. Nat. Sci. Phila. (2) III, p. 249.
1856. *Lachnosterna affinis* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 252.
1887. *Lachnosterna affinis* Horn, Trans. Amer. Ent. Soc. XIV, p. 238.
1887. *Lachnosterna corrosa* Horn, Trans. Amer. Ent. Soc. XIV, p. 255.
1889. *Lachnosterna affinis* Smith, Proc. U S. Nat. Mus. XI, p. 498.
1889. *Lachnosterna corrosa* Smith, Proc. U. S. Nat. Mus XI, p 512.
1916. *Phyllophaga corrosa* Glasgow, Bull. Ill. State Lab. Nat. Hist XI, p. 372.
1916. *Phyllophaga affinis* Glasgow, Bull. Ill. State. Lab. Nat. Hist. XI, p. 372.

A rare species in the area under discussion. All of the specimens were taken at lights, except one female found feeding on a weed in pasture land at 10 a.m., June 11, 1918.

Collections: At lights, 17; on food plants, 1; total, 18.

Period of flight. May 17 to June 23.

Lachnosterna rugosa Melsheimer.

1846. *Ancylonycha rugosa* Melsheimer, Proc. Acad. Nat Sci. Phila. II, p 140
1855. *Lachnosterna rugosa* Burmeister, Handb Ent. IV, 2, p. 328
1856. *Lachnosterna rugosa* LeConte, Journ Acad. Nat Sci Phila (2), III, p 252
1887. *Lachnosterna rugosa* Horn, Trans. Amer. Ent. Soc. XIV, p. 259.
1889. *Lachnosterna rugosa* Smith, Proc. U. S. Nat. Mus XI, p. 513.
1916. *Phyllophaga rugosa* Glasgow, Bull. Ill. State Lab. Nat Hist. XI, p 371.

Rugosa is one of the more common species, comprising about 5 per cent of the total collections. This species is a rather general feeder, as will be noted in the list of food plants.

Collections At lights, 1,822; on food plants, 228; in soil, 11; total, 2,061.

Period of flight. April 23 to July 12.

Principal food plants Willow, locust, hawthorne, hackberry, silver poplar and birch.

Incidental food plants· Box elder, oak, cottonwood, coffee tree, horse chestnut, cherry, plum, Norway maple, peach, persimmon, pear, elm, redbud, strawberry, ash, spirea, apple, linden and catalpa.

Lachnosterna implicita Horn.

1887. *Lachnosterna implicata* Horn, Trans Amer Ent Soc XIV, p. 282
1889. *Lachnosterna implicata* Smith, Proc. U S. Nat. Mus XI, p. 515.
1897. *Lachnosterna minor* Linell, Proc U. S Nat. Mus. XVIII, p 728
1916. *Phyllophaga implicata* Glasgow, Bull Ill. State Lab. Nat Hist XI, p. 373.
1916. *Phyllophaga minor* Glasgow, Bull. Ill. State Lab. Nat Hist. XI, p. 373

Implicita ranks sixth in importance in this locality and comprises about 2 per cent of the total collections. This species is comparatively rare at lights, and during 1917 and 1918 about 87 per cent of the 344 beetles taken were found on trees. The collections show that the females greatly predominate, 95 per cent of the total collection being of this sex.

Collections· At lights, 240; on food plants, 489; in soil, 11; total, 740.

Period of flight· May 6 to July 21.

Principal food plants· Willow.

Incidental food plants: Apple, silver poplar, cottonwood, locust, hackberry, linden, elm, hawthorne, redbud, horse chestnut, cherry, curled dock.

Lachnosterna hirticula Knoch.

1801. *Melolontha hirticula* Knoch, Neue. Beytr. Ins. I, p. 79.
1817. *Melolontha hirticula* Schonherr, Syn Ins I, 3, p 178.
1842. *Phyllophaga hirticula* Harris, Rept. Ins. of Mass, 2 Ed., p 28.
1855. *Ancylonycha hirticula* Burmeister, Handb Ent. IV, 2, p. 327.
1856. *Lachnosterna hirticula* LeConte, Journ. Acad. Nat Sci Phila. (2) III, p. 254.
1887. *Lachnosterna hirticula* Horn, Trans Amer. Ent. Soc. XIV, p. 266
1889. *Lachnosterna hirticula* Smith, Proc. U. S. Nat Mus. XI, p. 516.
1916. *Phyllophaga hirticula* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

Hirticula ranks eighth in importance in this locality. The specimens from this locality have fewer hairs than those collected further east, and Mr. J. J. Davis, in correspondence, suggests that the form found in Kansas may be a variety.

Collections: At lights, 524; on food plants, 50; total, 574.

Period of flight: May 17 to August 7.

Principal food plants: Hawthorne, birch and oak.

Incidental food plants: Persimmon, coffee tree, elm, plum and horse chestnut.

Additional notes: The Agricultural College collection contains ten specimens found feeding on *Ceanothus ovatus*, dogwood and shoestring plant in May, 1889. There are also four specimens taken on willow at the same time

Lachnosterna ilicis Knoch.

1801. *Melolontha ilicis* Knoch, Neue. Beytr Ins I, p 75
1830 *Melolontha porcina* Hentz, Trans. Amer. Phil. Soc (2) III, p. 256.
1850. *Ancylonycha ilicis* Blanchard, Cat. Coll Ent Mus Nat Hist. de Paris I, p 133.
1855 *Ancylonycha fimbriata* Burmeister, Handb. Ent IV, 2, p 326.
1856. *Lachnosterna ciliata* LeConte, Journ Acad Nat Sci. Phila. (2) III, p. 253.
1856 *Lachnosterna ilicis* LeConte, Journ Acad Nat Sci Phila (2) III, p 253
1887. *Lachnosterna ilicis* Horn, Trans Amer. Ent Soc XIV, p. 268.
1887. *Lachnosterna ciliata* Horn Trans Amer Ent. Soc XIV, p. 269
1889 *Lachnosterna ilicis* Smith, Proc. U S. Nat Mus XI, p 517
1889. *Lachnosterna ciliata* Smith, Proc. U. S Nat Mus XI, p 517
1916. *Phyllophaga ilicis* Glasgow, Bull. Ill State Lab. Nat Hist. XI, p. 371.
1916 *Phyllophaga porcina* Glasgow, Bull Ill. State Lab Nat Hist XI, p 371.
1916. *Phyllophaga fimbriata* Glasgow, Bull Ill. State Lab Nat. Hist XI, p. 371
1916 *Phyllophaga ciliata* Glasgow, Bull Ill. State Lab Nat. Hist XI, p 371.

One male of this species was taken under an electric light June 23, 1917.

Lachnosterna crenulata Froelich.

1792 *Melolontha crenulata* Froelich, Der Naturforscher, Stueck 26, p. 94
1801 *Melolontha crenulata* Froelich, Der Naturforscher, Stueck 29, p. 111.
1817 *Melolontha georgicana* Gyllenhal, Schon Syn Ins, Band I, Teile 3, p. 171; appendix, p 77
1855 *Ancylonycha crenulata* Burmeister, Handb. Ent IV, 2, p. 327
1856 *Lachnosterna crenulata* LeConte, Journ Acad. Nat Sci Phila (2) III, p 258
1887 *Lachnosterna crenulata* Horn Trans. Amer Ent. Soc XIV, p. 272.
1889 *Lachnosterna crenulata* Smith, Proc. U. S Nat Mus XI, p 518
1916 *Phyllophaga crenulata* Glasgow, Bull Ill State Lab Nat Hist. XI, p. 370.
1916 *Phyllophaga georgicana* Glasgow, Bull Ill State Lab. Nat Hist. XI, p. 370.

Crenulata is not common to this area. It appears late in the season, and apparently is not strongly attracted to lights.

Collections: At lights, 32; on food plants, 43; total, 75.

Period of flight June 2 to September 3.

Principal food plants· Linden.

Incidental food plants: Birch, horse chestnut, strawberry, locust, cherry, hawthorne, plum, Virginia creeper, elm, box elder, willow.

Lachnosterna rubiginosa LeConte.

1856. *Lachnosterna rubiginosa* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 259.
1887. *Lachnosterna rubiginosa* Horn, Trans Amer Ent Soc XIV, p. 275.
1889. *Lachnosterna rubiginosa* Smith, Proc. U S Nat. Mus XI, p. 519.
1916. *Phyllophaga rubiginosa* Glasgow, Bull. Ill State Lab. Nat. Hist. XI, p. 373.

Rubiginosa ranks second among the night-flying *Lachnosterna* of Riley county, comprising 15 per cent of the total collections. Knaus (1897), in reporting this species from Douglas county and Manhattan, speaks of it as being rare. The collections show that *rubiginosa* is more abundant on food plants than at lights. The males greatly predominate in the collections made at lights, while there is a slight preponderance of females in those from trees.

Collections: At lights, 1,798; on food plants, 4,236; in soil, 47; total, 6,081.

Period of flight: April 18 to August 8.

Principal food plants: Hawthorne, horse chestnut, locust, hackberry, oak, elm, coffee tree.

Incidental food plants: Linden, birch, Norway maple, redbud, tulip, box elder, ash, apricot, cherry, peach, persimmon, strawberry, silver poplar, larch.

Additional notes: The Agricultural College collection contains 149 specimens found feeding on *Ceanothus ovatus*, dogwood, and shoestring plant dur-

ing May, 1889. Most of these were on the former. There is also one specimen which was shaken from a maple tree at 1 p.m. June 7, 1889, and one beetle that was taken on plum, May 9, 1892.

Lachnosterna submucida LeConte.

1856 *Lachnosterna submucida* LeConte, Journ Acad Nat Sci Phila (2) III, p 260
1887. *Lachnosterna submucida* Horn, Trans Amer Ent Soc. XIV, p. 277
1889. *Lachnosterna submucida* Smith, Proc U S Nat Mus XI, p 519
1916. *Phyllophaga submucida* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p 373.

A rare species in this locality, appearing late in the season. While it is apparently a night flier, two specimens were collected while feeding during the day. In a series of *Lachnosterna* collected at Junction City in June and July, 1916, this species comprised 40 per cent of the total number taken.

Collections. At lights, 13; on food plants, 2; in soil, 2; total, 17.

Period of flight: July 7 to August 17.

Food plants Big bluestem.

Lachnosterna glabricula LeConte.

1856. *Lachnosterna glabricula* LeConte, Journ Acad Nat Sci Phila (2) III, p 260
1887. *Lachnosterna glabricula* Horn, Trans Amer Ent Soc XIV, p 277
1888. *Lachnosterna glabricula* Bates, Biol. Centr Amer Col II, 2, p 210
1889. *Lachnosterna glabricula* Smith, Proc U. S Nat Mus XI, p 520
1916 *Phyllophaga glabricula* Glasgow, Bull. Ill State Lab Nat Hist. XI, p 373.

Glabricula is rather common during July and August With the exception of three females taken in the soil around the roots of sumac, the collections have consisted of males. The female of this species has not been described and it is only recently that it has been recognized.

Collections: At lights, 252; on food plants, 1; in soil, 4; total, 257.

Period of flight· June 28 to September 6.

Food plants· Horseweed.

Lachnosterna inepta Horn.

1887. *Lachnosterna inepta* Horn Trans Amer Ent Soc XIV, p 282
1889. *Lachnosterna inepta* Smith, Proc U. S Nat Mus XI, p 520
1916. *Phyllophaga inepta* Glasgow, Bull. Ill State Lab. Nat Hist XI, p 373

One male was taken under an electric light September 5, 1917. This is the first record of this species occuring in this state

Lachnosterna affabilis Horn.

1887. *Lachnosterna affabilis* Horn, Trans. Amer Ent Soc XIV, p 283
1889. *Lachnosterna affabilis* Smith, Proc. U S Nat. Mus XI, p 521
1916 *Phyllophaga affabilis* Glasgow, Bull. Ill State Lab Nat Hist XI, p 373

One male of this species was taken under an electric light August 13, 1917 *Affabilis* was described by Horn from specimens obtained in Kansas, and in so far as the writers have been able to determine, it has not been recorded elsewhere. In addition, the Agricultural College collection contains one specimen collected at lights July 27, 1889, and one specimen caught in a trap in an orchard July 29, 1889.

Lachnosterna tristis Fabricius.

1781. *Melolontha tristis* Fabricius, Species Insectorum, I, p 39
1801. *Melolontha pilosicollis* Knoch, Neue. Beytr. Ins I, p 85
1817. *Melolontha pilosicollis* Schoenherr, Sys Ins I, 3, p. 177.
1817. *Melolontha tristis* Schoenherr, Sys. Ins I, 3, p 195.
1823. *Melolontha pilosicollis* Say, Journ Acad. Nat. Sci. Phila. III, p. 243; Ed. Le Conte (1869), p. 143.
1842. *Melolontha pilosicollis* Harris, Rept. Ins. of Mass. Inj. Veg Ed 2, p. 28.
1847. *Trichesthes pilosicollis* Erichson, Naturges. der Ins. Deutschlands III, p. 658.
1850. *Trichestes pilosicollis* Blanchard, Cat. of Coll. Ent. Mus. Nat. Hist. de Paris I, p. 141.
1855. *Ancylonycha tristis* Burmeister, Handb. Ent. IV, 2, p 358.
1856. *Lachnosterna tristis* Le Conte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 261.
1873. *Lachnosterna pilosicollis* Le Conte, Proc. Acad. Nat. Sci. Phila. XXV, p. 330.
1887. *Lachnosterna tristis* Horn, Trans. Amer. Ent. Soc. XIV, p. 286.
1889. *Lachnosterna tristis* Smith, Proc U. S. Nat. Mus. XI, p. 522.
1916. *Phyllophaga tristis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 370.
1916. *Phyllophaga pilosicollis* Glasgow, Bull. Ill. State Lab. Nat Hist. XI, p. 370.

A rare species in this locality, six specimens having been taken in the three years collecting.

Collections. At lights, 1; on food plants, 1; in soil, 4; total, 6.

Period of flight: May 23 to June 5.

Food plants: Willow.

Additional notes: The Agricultural College collection contains one specimen taken on willow, May 22, 1889, and one specimen from *Ceanothus ovatus*, May 23, 1889

ADDITIONAL SPECIES.

Lachnosterna ephilida Say.

1825. *Melolontha ephilida* Say, Journ Acad. Nat Sci Phila V, I, p 196; Le Conte, Ed. II (1869), p 298.
1855. *Trichestes ephilida* Burmeister, Handb Ent IV, 2, p 359
1856 *Lachnosterna ephilida* LeConte, Journ. Acad. Nat Sci Phila (2) III, p 241
1856 *Lachnosterna burmeisteri* LeConte, Journ Acad Nat Sci Phila (2) III, p 242
1887 *Lachnosterna ephilida* Horn, Trans Amer Ent Soc XIV, p 225.
1889 *Lachnosterna ephilida* Smith, Proc U S Nat Mus XI, p 496
1916. *Phyllophaga ephilida* Glasgow, Bull Ill State Lab Nat Hist XI, p 371
1916 *Phyllophaga burmeisteri* Glasgow, Bull. Ill State Lab Nat Hist XI, p 371

The collection of the department of entomology contains one male collected at lights, July 21, 1903, by N. L. Towne.

Lachnosterna balia Say.

1825 *Melolontha balia* Say, Journ Acad Nat Sci Phila V, p 191, Ed LeConte (1869), p 297
1855 *Ancylonycha comata* Burmeister, Handb Ent IV, 2, p 337
1856 *Lachnosterna balia* LeConte, Journ Acad Nat Sci Phila (2) III, p 255
1887 *Lachnosterna balia* Horn, Trans Amer. Ent. Soc. XIV, p. 262
1889 *Lachnosterna balia* Smith, Proc U S Nat Mus XI, p 516
1916 *Phyllophaga balia* Glasgow, Bul Ill State Lab. Nat. Hist XI, p 371
1916 *Phyllophaga comata* Glasgow, Bull Ill State Lab Nat Hist XI, p 371

Knaus (1897) reports this species as occurring in the collection of the Agricultural College from Manhattan. Thus far the writers have been unable to locate the specimens. Knaus says *balia* is rare.

Lachnosterna parvidens Le Conte.

1856 *Lachnosterna parvidens* LeConte, Journ Acad Nat Sci Phila (2) III, p 259
1887 *Lachnosterna parvidens* Horn, Trans. Amer Ent Soc XIV, p 275
1889 *Lachnosterna parvidens* Smith, Proc U S Nat Mus XI, p 519
1916 *Phyllophaga parvidens* Glasgow, Bull Ill State Lab Nat Hist XI, p 373

Reported by Knaus (1897) as occurring in the collection of the Agricultural College from Manhattan. According to Knaus, it is rare in this state.

Lachnosterna forsteri Burmeister.

1855 *Ancylonycha forsteri* Burmeister, Handb Ent IV, 2, p 325
1856. *Lachnosterna semicribrata* LeConte, Journ Acad Nat Sci Phila (2) III, p 247
1856. *Lachnosterna lugubris* LeConte, Journ Acad. Nat. Sci Phila. (2) III, p. 248
1856. *Lachnosterna lutescens* LeConte, Journ. Acad Nat Sci Phila (2) III, p 249
1887 *Lachnosterna politula* Horn, Trans Amer Ent Soc XIV, p. 248
1887 *Lachnosterna lutescens* Horn, Trans Amer Ent Soc XIV, p. 248
1887. *Lachnosterna forsteri* Horn, Trans Amer. Ent. Soc XIV, p 248
1887. *Lachnosterna lugubris* Horn, Trans Amer. Ent. Soc. XIV, p. 248
1887. *Lachnosterna semicribrata* Horn, Trans Amer Ent Soc XIV, p 248
1889. *Lachnosterna nova* Smith, Ent Amer V, p. 95
1889. *Lachnosterna politula* Smith, Proc. U. S Nat Mus XI, p 507
1889. *Lachnosterna forsteri* Smith, Proc U S. Nat Mus. XI, p. 508
1889. *Lachnosterna semicribrata* Smith, Proc U S Nat Mus XI, p 508
1889. *Lachnosterna nova* Smith, Proc U. S. Nat Mus XI, p. 509
1916. *Phyllophaga forsteri* Glasgow, Bull Ill State Lab. Nat. Hist , XI, p. 372.
1916. *Phyllophaga semicribrata* Glasgow, Bull. Ill. State Lab Nat. Hist., XI, p. 372.
1916. *Phyllophaga lugubris* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 372
1916. *Phyllophaga lutescens* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 372.
1916. *Phyllophaga politula* Glasgow, Bull. Ill. State Lab. Nat Hist., XI, p 372.
1916. *Phyllophaga nova* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 372.

This species is reported by Knaus (1897) from Manhattan and Topeka under the name *Lachnosterna fraterna* variety *lugubrus* LeConte.

Lachnosterna fraterna Harris.

1842. *Phyllophaga fraterna* Harris, Rept. Ins. Inj. Veg. Mass., p. 29: Ed., 2, p. 28.
1850. *Ancylonycha fraterna* Blanchard, Cat. Coll. Ent. Mus. Nat. Hist. de Paris, p. 133.
1855. *Ancylonycha cognata* Burmeister, Handb. Ent. IV, 2, p. 323.

1856. *Lachnosterna cognata* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 248.
1856. *Lachnosterna fraterna* LeConte, Journ. Acad. Nat. Sci Phila (2) III, p. 249.
1887. *Lachnosterna fraterna* Horn, Trans Amer. Ent Soc. XIV, p 251.
1887. *Lachnosterna cognata* Horn, Trans Amer. Ent Soc. XIV, p 252
1889. *Lachnosterna fraterna* Smith, Proc. U. S Nat. Mus. XI, p. 508.
1889. *Lachnosterna cognata* Smith, Proc U S Nat Mus XI, p. 508
1891. *Lachnosterna fraterna* Hamilton, Ent. News, II, p. 136
1916. *Phyllophaga fraterna* Glasgow, Bull. Ill State Lab Nat. Hist XI, p 371
1916. *Phyllophaga cognata* Glasgow, Bull. Ill State Lab. Nat. Hist, p 371

Fraterna is reported by Knaus (1897) as occurring in the Agricultural College collection from Riley county. He says that it is present during July and is a rare species.

Lachnosterna profunda Blanchard.

1850. *Ancylonycha profunda* Blanchard, Cat Coll. Ent Mus Nat Hist de Paris, I, p. 132.
1855 *Ancylonycha profunda* Burmeister, Handb Ent IV, 2, p. 321
1873 *Lachnosterna profunda* LeConte, Proc. Acad Nat. Sci Phila. XXV, p 330.
1887. *Lachnosterna profunda* Horn, Trans Amer Ent Soc. XIV, p. 257
1889 *Lachnosterna profunda* Smith, Proc. U S. Nat Mus. XI, p. 513
1889 *Lachnosterna biimpressa* Smith, Ent Amer V, p. 97
1889. *Lachnosterna biimpressa* Smith, Proc U. S Nat Mus XI, p 511
1897. *Lachnosterna grandior* Linell, Proc U S Nat Mus XVIII, p 727
1916. *Phyllophaga profunda* Glasgow, Bull. Ill State Lab. Nat. Hist, XI, p 371
1916. *Phyllophaga biimpressa* Glasgow, Bull Ill State Lab Nat. Hist XI, p 371
1916. *Phyllophaga grandior* Glasgow, Bull Ill State Lab Nat Hist XI, p. 371

Smith (1889) described *Lachnosterna biimpressa* from a single male from Manhattan, 1876 According to Glasgow (1916), *biimpressa* is a synonym of *profunda*.

In addition to the species listed above, Knaus (1897) reports *Lachnosterna albina* Burm., *L. subpruinosa* Casey, and *L. marginalis* Lec. as occurring in the collection of the Agricultural College from Riley county. In going over this collection the writers found five specimens labeled *albina*. These were submitted to Mr. J. J. Davis, who pronounced them *rubiginosa*. The specimens of *subpruinosa* have not been found, but in conversation with Dr. R. D. Glasgow he stated that this species is strictly an eastern form A large number of specimens labeled *marginalis* in the College collection proved to be *rugosa*.

SUMMARY.

The genus *Lachnosterna* offers an excellent field for the study of many phases of insect bionomics, and especially some of the problems concerned in animal distribution. It is necessary, however, that extensive collections of beetles be made from many localities in each state before the definite distribution can be worked out.

The members of this genus include some of the most injurious insects occurring in the United States. They attack crops of all kinds, causing a loss of many millions of dollars annually.

Distribution is influenced by a number of factors, chief of which are latitude, altitude, temperature, moisture, food and soil.

Dispersal occurs principally in the adult stage, and may be by flight, winds, storms, floods or running water.

The genus *Lachnosterna*, composed of approximately 232 species, is confined almost entirely to the Western Hemisphere. Ninety-seven species have been recorded from the United States, and about fifty of these occur in Kansas.

During the past three years the writers have collected 41,633 beetles, representing 23 species, in the vicinity of Manhattan. Six additional species have been reported from this locality and are added to the list.

An annotated list of the 29 species is presented, with notes on relative abundance, period of flight, and food.

Five species, *crassissima, lanceolata, rubiginosa, futilis* and *rugosa,* occur in sufficient numbers to be a serious menace to crops. Five other species occurred in moderate numbers, indicating that they may at times become injurious. These are *implicata, bipartita, hirticula, vehemens,* and *glabricula.*

Four species, *longitarsa, crenulata, fusca* and *congrua,* are not common to this locality; and nine species, *prœtermissa, inversa, fervida, corrosa, ilicis, submucida, inepta, affabilis* and *tristis,* are rare.

Six additional species are represented in the collection of the Agricultural College, or reported in literature from this locality. These are *ephilida, balia, parvidens, forsteri, fraterna* and *profunda.*

Two of the species represented in the writers' collection, namely, *prœtermissa* and *inepta,* have not been previously reported from Kansas.

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Notes on Larval Trematodes from the Laramie Plains.

EARL C O'ROKE.

During the past two summers the writer has been studying the fauna of the Laramie plains in southern Wyoming, in the hope that data might be obtained that would be of use in solving the problems involved in the life histories of some of the trematode worms.

The Laramie plains are peculiarly situated geographically, in that there are mountain barriers to the east, south and west. The only stream that drains the region is the Laramie river, which flows in a northeasterly direction and joins the Platte. Rapids in this stream where it goes through the mountains constitute an effective barrier to many forms of aquatic life. Ponds are numerous in the vicinity of Laramie, almost all of them being alkaline and having their source of water supply in seepage from irrigation ditches. These ponds have an abundant growth of algæ and other forms of plant life and harbor myriads of small crustaceans belonging to the Entomostraca, as well as numer-

ous aquatic insects. The only vertebrates found in the ponds are the common leopard frog, *Rana pipiens,* and the spotted salamander, *Ambystoma tigrinum.* Two species of snails, *Glba palustrus* and *Physa integra,* are found in enormous numbers. As regards the mammals inhabiting the plains, ground squirrels, field mice, prairie dogs, jack rabbits, badgers and coyotes are found. There are muskrats in the river, but these have not been seen in and about the ponds. Of the mammals mentioned above, only the first two forms have been seen in the immediate vicinity of the ponds that have been studied most, namely, the ones near the farm site on the university stock farm at Laramie.

It is true that migratory birds could gain access to these ponds, but only three species have ever been observed near the ponds. These are the yellow-headed blackbird, the cliff swallow and Wilson's snipe.

The ponds are for the most part shallow and are frozen solid for from four to six months of the year.

Examination of the two species of snails previously mentioned shows them to be heavily infected with larval trematodes of at least three different species, none of which have as yet been fully identified Notwithstanding this heavy infection of the snails, no adult trematodes have as yet been found in any of the possible vertebrate hosts.

Some experimental work has been undertaken, in which young frogs brought from another locality were liberated in cages in a pond with infected snails. The results were negative. Likewise, salamanders confined in an aquarium with infected snails gave no evidence of trematode infection

Studies have been made on the seasonal appearance of the cercariæ and interesting records obtained. The time during which cercariæ may be found emerging from snails is much shorter than in Kansas, where the writer made extensive studies of these parasites in 1915 and 1916. Further studies are planned for the summer of 1919.

Plant Diseases Heretofore Unreported in Kansas.

L. E. MELCHERS

REPORTED IN 1914.

**Heterodera radicicola,* root knot on Canada thistle (*Circium arvense*). Manhattan.

Blossom-end-rot, tomato; nonparasitic. All over the state.

Septoria sp., sweet-potato leaf spot. Manhattan, Wamego.

Heterodera radicicola, root knot on cucumber. Hutchinson.

Heterodera radicicola, celery root knot.

Colletotrichum trifolii Bain, stem disease of alfalfa. Manhattan.

Fungous root trouble of wheat. Undetermined. Manhattan, Moline, Speed, Stockton.

Coniosporium gecevii, corn-cob rot. Manhattan.

Fusarium batatis (*hyperoxysporum*), wilt of sweet potato. Wamego, Manhattan.

Fusarium vasinfectum var. *tracheiphilis,* cowpea wilt.

Nummularia discreta Tul. Heretofore unreported in state, but known. Apple.

*Black chaff and stem disease of wheat. Bacterial.

Phyllosticta solitaria E. and E. Heretofore unreported in state, but known. Apple.
**Heterodera radicicola*, root knot on Madagascar periwinkle.
**Heterodera radicicola*, root knot on marguerite.
**Heterodera radicicola*, root knot on cockscomb.
**Heterodera radicicola*, root knot on phlox.
**Heterodera radicicola*, root knot on parsley.
**Pleosphærulina briosiana* Pol., alfalfa leaf-spot disease

* New to science

REPORTED IN 1915.

Chlorosis of red cedar, nonparasitic Hays
Phyllosticta medicaginis, alfalfa leaf-spot disease. All over state.
Raspberry curl, nonparasitic disease Troy, Wathena
Bacillus tracheiphilus, wilt of cucumber
Phoma sp., stem disease of alfalfa. Manhattan, Hays, Garden City.
Sorghum-root disease Undertermined Manhattan.
Physoderma sp., on corn. Manhattan
Fusarium sp., corn-root rot
Fusarium wilt, watermelon

REPORTED IN 1916-1917.

Soil rot or pox disease of sweet potato.
Coniothyrium sp., apple-tree canker.
**Alternaria* sp., black spot of pepper.
**Botrytis* sp. Causes severe injury to flowers and foliage of geranium plants.
*Bacterial disease of lettuce in greenhouse.
*Bud blight of sorghums. Fungous disease.
Seeding blight of sorghums. Fungus.

' New to science

Plant-disease Survey Report for Kansas, 1918.

L. E. Melchers, Collaborator, United States Department of Agriculture and State Plant Pathologist

CEREAL DISEASES.

A rather complete survey of the state was made by the Office of Cereal Investigations in cooperation with the Office of Plant Disease Survey; therefore, the reports herein which consider cereal diseases are those in addition to the observations made by these offices.

BARLEY DISEASES.

In a general way, barley diseases were present in about the same amounts as usual. In most fields where the seed had not been treated from 2 to 5 per cent of covered smut and the same percentage of loose smut were found. These are invariably present in all barley fields.

There was practically no evidence of leaf rust of barley in the state the past season, and no stem rust was called to the collaborator's attention. None of the leaf spots were found occurring on this crop.

OAT DISEASES.

Stem rust of oats occurred to a slight extent during the fall of 1918 on volunteer plants. No stem rust was called to the collaborator's attention during the regular season.

Leaf rust was rather uncommon the past season In most fields there was scarcely a trace to be found.

Covered and *loose smut* were prevalent in Kansas the past season. The loose smut generally predominates, but this year there seemed to be a considerable amount of covered smut Campaigns for seed treatment were most effective the past season, and it is estimated that about 50 per cent of the oat seed planted was treated for smut.

Bacterial blight. A few cases of bacterial blight of oats was called to the writer's attention. Apparently this was not serious the past season.

RYE DISEASES.

Leaf rust. There was no evidence of leaf rust nor smut in the rye crop of the fields inspected. Ergot was not called to the collaborator's attention. The crop was practically disease free the past season.

WINTER WHEAT.

Loose smut can be reported from practically every section of the state where wheat is grown. The percentage does not seem to be on the increase. It varies from a mere trace to a quarter or half of one per cent in the majority of the fields. Although widely spread, it is not regarded as serious.

Covered smut. This disease was more common the past season than it has been for a number of years in some of the eastern counties and the northeastern part of the state, where many fields were badly diseased. The percentage ran as high as 40 in some fields, although 5 or 10 per cent was in the great majority of fields where smut occurred. Johnson county in particular had a great deal of covered smut Considerable seed treatment was carried out this fall (1918), and there will probably be less indication of bunt next year.

Leaf rust. This disease was present in practically every wheat field. It varied from a few per cent to 85 per cent, using the scale as advised by the Office of Cereal Investigations. There was apparently no damage to the crop from this rust.

Stem rust. This was very uncommon except in mere traces in some fields in the state. The past fall (1918), although most favorable for stem rust to start, the wheat crop became covered with a blanket of snow, with practically no indication whatsoever of stem rust in the crop. In September and October there were slight traces here and there on volunteer wheat or in the fall-sown crop, but during October, November and December this had practically all died out, with no indications of spreading.

*Black chaff disease.** This disease was reported from about twelve different

* It is desirable to call attention to the fact that this disease has been sadly confused with the blackening of the glumes of wheat caused by *Septoria*. Some of the states have sent in reports in which it is known by the writer that the disease was due to *Septoria* and not the bacterial black chaff.

counties in the state this year. It probably occurred in traces in a great many others. No indications of damage to the crop occurred.

Powdery mildew. One report of this disease on wheat came from Cowley county. No injury resulted.

Septoria. This disease was practically absent from the mature crop, but due to the wet fall which occurred in Kansas, considerable leaf spot due to the *Septoria* occurred. This in all probabilities will cause some infection on the mature plants if a wet spring occurs.

ALFALFA.

Phoma sp. This was reported for the first time by the writer in 1915, and has been present more or less each season. It was present to a slight extent the past season. It causes black lesions on the stems, which if severe cause the death of shoots.

Leaf spot (Pyrenopeziza medicaginis). This disease was reported from Marion county the past season, where it appeared to be fairly common. It was not common throughout the state.

Alfalfa-root rot (Rhizoctonia violaceæ). This disease was reported from Osage county It is known to occur in several sections of the state.

CORN.

Rust. This occurred in many sections of the state to a greater or less extent. No injury resulted.

Corn smut varied anywhere from 1 to 40 per cent in various fields. A conservative estimate of the total crop lost by smut for 1918 is about 8 per cent.

Corn-root rot (Fusarium sp.). This was fairly common throughout the state. It was reported the past year in Anderson, Lyon and Riley counties. Perhaps 10 per cent of the total crop was lost by this disease, although it is possible that this percentage is low.

SORGHUM DISEASES.

Head smut occurred in slight amounts in Riley county This disease is not on the increase in this state.

Kernel smut. This varied from a few per cent to 25 or 30 per cent of the crop in many fields; perhaps an average of 10 per cent loss of the total crop would be a conservative estimate. Considerable seed treatment was carried out successfully.

VEGETABLE DISEASES.

BEAN.

Bacterial blight is reported in Coffey and Riley counties. From 1 to 2 per cent appeared.

Mosaic disease. This disease occurred in numerous parts of the state fairly abundantly. It seems to be on the increase in this state.

CUCUMBERS.

Bacterial wilt. This was reported in a few counties in the state. From 1 to 2 per cent injury resulted due to this disease. For the most part the weather conditions were so unfavorable that the crop could not mature.

BEETS.

Beet leaf spot. This disease is more or less common wherever the beets are grown.

Beet scab This disease was reported from one place in Kansas. The county is not known at this time.

Crown gall. One case of crown gall was called to the collaborator's attention. This came from the same region where scab was reported.

CABBAGE.

Black rot was reported in Lyon and Riley counties, and from 5 to 25 per cent injury resulted.

Leaf spot (Alternara brassicæ). About 1 per cent of the crop was injured by this disease in Riley county.

CELERY.

Root knot or eel worm occurred in Reno county in the fields in the neighborhood of greenhouses It seems to live over winter in this state as past reports have indicated.

EGGPLANT.

Macrosporium sp. A more or less dry rot due to *Macrosporium* occurs on the eggplant, causing large sunken areas.

POTATO.

Early blight. Trace to 20 per cent occurred in the vicinity of Riley county It was not common in the state.

Wilt and dry rot occurred in many fields in the state. It was particularly abundant in Riley county. In Atchison and Anderson counties it occurred slightly. It no doubt appeared in many other fields in the state.

Rhizoctonia. This disease occurred in practically every field in the state where potatoes were planted with northern seed. The average loss for the state was perhaps 15 per cent. It is a serious disease in Kansas.

SWEET POTATO.

Pox disease is present in practically every field where sweet potatoes are grown. It has only been in this state about three years. The injury in many fields is very marked.

Black rot. This disease was more abundant the past year in the sweet-potato districts than usual. Perhaps from 1 to 3 per cent loss occurred.

Stem rot. The average loss from this disease in the state is perhaps 10 to 15 per cent.

Storage rots. Twenty per cent of the crop is frequently lost due to *Rhizopus* and closely related soft rots.

FRUIT DISEASES.

APPLE.

Blister canker. This disease occurs in practically every old orchard in the state. Anywhere from 1 to 80 per cent of the trees are dying in different orchards. It has been reported the past season in Rooks, Riley, Morris, Washington, Chase, Kingman, Greenwood, Labette, Cherokee, Sumner, Bourbon, Crawford, Sedgwick and Reno counties.

Black rot. This disease was rather rare in Kansas. The loss for 1918 was perhaps less than one-fifth of 1 per cent.

Blotch was common in every orchard in the state. The average loss to the fruit crop for 1918 was perhaps 10 per cent.

Rust was very rare in the state and only occurred on apple foliage.

Fire blight caused perhaps an average of 2 per cent loss for the state.

Apple canker (*Leptosphæria coniothyrium*) occurred in Jefferson, Wabaunsee, Doniphan and Sumner counties. Perhaps 10 per cent of the young trees in these counties were affected, with a loss of about 3 per cent of the trees.

Sun scald and *winter injury* made their appearance in some regions, but with no serious loss.

Apple scab was reported in Cherokee, Miami, Sedgwick and Greenwood counties. Less than one-fifth of 1 per cent injury resulted.

BLACKBERRY.

Leaf spot. This disease occurred to a greater or less extent in all patches of blackberries

PLUM

Brown rot was common on the trees in all sections of the state.

Plum pockets reported from Kingman and Greeley counties, where it was fairly common.

RASPBERRY.

Anthracnose was common in Doniphan county, from 1 to 10 per cent injury resulting in various patches.

Cane blight was common in Doniphan and Riley counties. Perhaps 10 per cent of the crop was injured by this disease.

WATERMELON.

End rot (*Diplodia*). Perhaps 8 per cent of the crop was lost in Riley and Sedgwick counties due to this disease.

Anthracnose was reported in various fields in Riley county From 1 to 2 per cent loss occurred.

Fusarium end rot. In Riley county 8 per cent of the fruit seemed to be affected.

GENERAL CONCLUSIONS.

In all, the plant disease situation for Kansas was nothing out of the ordinary. No epidemics of any disease occurred, and for the most part the different diseases occurred in normal amounts. The only new disease of economic importance occurring in Kansas for 1917-'18 was the apple disease canker due to *Leptosphæria coniothyrium*.

The House Fly and Fowl Tapeworm Transmission.[1]

JAMES E. ACKERT.

That chickens may be infested with tapeworms has long been known. In the United States seven different species have been taken from fowls, and in Kansas five of these species are commonly found. Chickens kept in small inclosures are less likely to be infested than are those which have free range of the premises. It is to the latter type, the general farm chicken, that most of the writer's attention has been directed. To date the entrails of 161 fowls from the farms in the vicinity of Manhattan, Kan., have been examined. From 121, or 75.1 per cent of them, tapeworms were removed. The infestation varied from 1 to 200 or 300, and in one instance a young chick contained 443 of these parasitic worms. Fourteen to twenty-seven worms are common, and this number may make a visible effect upon the fowl, causing emaciation, failure to develop feathers, and general debility. On the other hand, some fowls are strong enough to harbor as many as 40 of these worms and still have a healthy appearance. The average infestation for the 121 chickens was 26.7 worms per fowl. In this connection may be cited the case of a chick hatched on May 20, 1917. Two and one-sixth months later the chick was examined and the small intestine harbored a total of 443 tapeworms. This little chick was totally without feathers, except for a few which were distributed over the top of the wings and on a narrow strip on each side of the breast. The chick weighed four and one-half ounces. Three normal chicks from the same lot. which had been kept under the same conditions (the run of the place), weighed 20, 28 and 28 ounces, respectively

It is well known that the tapeworm attaches its head or scolex to the intestinal wall of the host, that the segments which form in the region of the neck gradually develop both male and female organs, and that within a few weeks the most posterior segments become filled with eggs, or, rather, hooked embryos. At this time these gorged segments are ready to be broken from the tapeworm and passed to the exterior, where some of the embryos may be swallowed by a suitable intermediate host, in which the larval tapeworm, or bladder worm, can develop. When the intermediate host containing the bladder worm is eaten by the final host, the larval tapeworm attaches its head to the intestinal wall and develops into the adult worm.

The search for suitable intermediate hosts, or the means by which tapeworms are transmitted from one chicken to another, has been a baffling problem. Two Italian investigators, Grassi and Rovelli, in the decade preceding 1892, finally found that a garden slug (*Limax cinereus* Lister) may be the intermediate host of the fowl tapeworm (*Davainea proglottina* Davaine) that is of rare occurrence in this country. Meggitt, in England, and Gutberlet and the writer, in this country, have been continuing the search much of the time during the last five years.

In 1916 Gutberlet[2] reported that the house fly (*Musca domestica* Lin.) may be the intermediate host of a chicken tapeworm, *Choanotænia infundi-*

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1. From the department of zoölogy, Agricultural Experiment Station of the Kansas State Agricultural College.

2. Gutberlet, J. E. 1916. Studies on the transmission and prevention of cestode infection in chickens. Jour. Am. Vet. Med. Assn., vol. 2, pp. 218-237.

buliformis (Goeze), but that he had failed to obtain any of the desired information on the remaining five species.

Among the small animals tested by the writer as possible intermediate hosts of these parasitic worms are crickets, three species of earthworms, house flies, May beetle larvæ, centipedes, sow bugs and four species of ground beetles, all of which are commonly found about rural poultry yards. Preliminary trials with the house fly in 1915 failed, but two years later experiments with this insect were resumed, with results showing that this fly may transmit another tapeworm, *Davainea cesticillus* (Molin), from one chicken to another.[3]

Similar experiments were continued in 1918, when it was found that the house fly is guilty of transmitting a third species of tapeworm, *Davainea tetragona* (Molin), from one fowl to another.[4] The experiments also confirmed Gutberlet's evidence against this fly.

It is obvious that scrupulous care must be exercised in experiments of this nature. Chicks hatched in incubators were taken at once to a screened feeding house with cement floor and eighteen-inch walls, where they were given food free from animal tissues except occasional feedings of fresh beef and the suspected intermediate hosts. Control chicks were kept with the experimental ones, and these were free from parasitic worms in every case.

House flies taken from nature were placed in lantern-globe cages and given tapeworm embryos in small drops of sweetened water. They were then fed daily upon sweet milk or sirup for two weeks to permit the tapeworm embryos to grow to the bladder-worm stage, when the flies were either preserved for study or given to certain chickens in the experimental feeding house.

In 1918 the chickens at two local poultry yards were found to be heavily infested with the tapeworm *Davainea tetragona*. The most common invertebrates were the house flies which covered the freshly voided feces. Large fly traps were set at these places and thousands of flies trapped and brought to the laboratory, where they were immersed in water several hours to facilitate in picking out the house flies (*Musca domestica*), which were then given to chickens in the experimental feeding house. It was found that house flies which were immersed in water sixteen hours would fully recuperate in two and one-half to three hours after their removal from the water. This indicated that any tapeworm larvæ in their bodies were uninjured by the immersion. Approximately 3,000 such house flies were fed, a few at a time, to each of 16 chicks. As a result three of these chicks became infested with a total of fourteen mature tapeworms, which upon examination were found to be *Davainea tetragona*. Twelve control chicks running with the others were entirely free from parasitic worms.

The larva of this tapeworm has not yet been seen in the house fly, but a series of experiments has proved that the house fly does ingest this tapeworm's embryos, and that the latter do not pass through the fly's alimentary canal unaltered.

SUMMARY.

1. Seven species of tapeworms are known to occur in fowls in the United States, and five of these have been collected in Kansas.

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3. Ackert, James E. 1918. On the life cycle of the fowl cestode *Davainea cesticillus* (Molin). Jour. Parasit., vol. 5, pp. 41-43.

4. Ackert, James E. 1919. On the life history of *Davainea tetragona* (Molin), a fowl tapeworm. Jour. Parasit., vol. 6, pp. 28-34.

2. Examinations of 161 spring chickens from farms near Manhattan, Kan., showed that 75.1 per cent of them were infested with tapeworms. The amount of infestation may vary from 1 to as many as 443 tapeworms; 10 to 27 are of more common occurrence, the average for infested fowls examined being 26.7 worms.

3. Tapeworms are transmitted from one chicken to another by means of an intermediate host in which the larval worm develops. The house fly (*Musca domestica* Lin.) is now known to transmit from one fowl to another three different species of tapeworms, viz., *Choanotænia infundibuliformis*, *Davainea cesticillus*, and *Davainea tetragona*

Studies on the Occurrence and Development of Ascaridia Perspicillum Parasitic in Chickens.[1]

BERTHA L DANHEIM

Among the internal parasites of fowls is *Ascaridia perspicillum*, a round worm one and one-half to four inches in length. It inhabits the small intestine and may be present in small or rather large numbers. Infestations ranging from ten to twenty mature worms are usually serious enough to make a visible effect upon the fowl, while thirty or more of these worms may result in the death of the chicken, due probably to the absorption of toxin produced by the worms.

That many fowls are infested in nature with this parasite is shown by the records of examinations in the parasitological laboratory during the last five years. Of a total of 424 examinations, 181 fowls, or 42.4 per cent of them, had these worms in their entrails. The smallest infestation was one and the largest seventy-five of these nematodes, the average for all infested fowls being 10.6 worms.

While this common parasite has been known for years, no careful observations of its development, of its resistance to extremes of temperature and humidity or of its means of transmission from one fowl to another have been reported. Studies on this problem were begun at this station in December, 1918, at the suggestion of Dr James E Ackert, under whose direction they have been continued

The facts determined to date may be summarized as follows·

1. In *Ascaridia perspicillum* the sexes are separate, the females being somewhat larger than the males.

2. These nematodes will live in normal saline solution at laboratory temperature for at least two weeks after their removal from the body of the fowl

3. To remove the eggs from the adult female the worm is placed in a Syracuse watch glass containing a small amount of saline solution (8 parts NaCl to 1,000 parts distilled H_2O). The body is opened with dissecting needles and the uteri are removed. By opening one end of the gorged uterus the eggs can be readily pressed out into the saline solution with a dissecting needle. They may then be left in the watch glass or transferred to culture cells.

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1. From the department of zoology, Agricultural Experiment Station of the Kansas State Agricultural College.

4. A single mature female contains approximately 1,500 eggs, which are just visible to the unaided eye.

5. The eggs are fertilized in the body of the female and covered with smooth, tough shells. Segmentation begins when the eggs pass from the body of the living nematode.

6. Fertilized eggs capable of development may be secured from nematodes kept in normal saline fourteen days after their removal from the chicken.

7. Eggs develop at laboratory temperatures in water, saline solution, or moist loam, but more satisfactory results are obtained when they are kept in saline solution in an incubator at 30° C.

8. Eggs are resistant to desiccation for at least seven days, as they resume development when saline is added.

9. Both fertilized and segmenting eggs (two-celled stage) are resistant to continuous freezing at 11° to 18° F. for 15 hours, but neither can endure 22 hours of such freezing.

10. Preliminary experiments indicate that unsegmented fertile eggs fail to develop in the digestive tracts of chickens, while eggs containing curved motile embryos hatch in the small intestine and are half grown in a month.

Kansas Rhynchophora in the Collection of the Kansas State Agricultural College.

WM. P. HAYES.*

The following list includes the species of Rhynchophora in the collection of the Kansas State Agricultural College. Many of the determinations were made by earlier workers in the College, among them being Popenoe, Dean, Marlatt, Norton and others. All determinations have been verified by the writer, who during the last four years has made a general study of the Rhynchophora available in this collection. Blatchley and Leng's arrangement of genera has been followed. This was deemed advisable, as the forthcoming check list of Coleoptera by Leng (the junior author) will probably follow somewhat closely this arrangement. The list includes 80 genera, represented by 169 species, among which are included 26 species, one variety and one color race not recorded in the lists of Kansas Coleoptera by Popenoe, Snow and Knaus. These are marked with an asterisk (*).

BRENTHIDÆ.

Eupsalis Lec.
minuta Drury. Riley county.

ANTHRIBIDÆ.

Eurymycter Lec.
fasciatus Oliv. "Kan."

Allandrus Lec.
bifasciatus Lec. Topeka, July.

Anthribus Geoff.
cornutus Say. Riley county, May, September, October.

* Contribution No. 44, from the Entomological Laboratory, Kansas State Agricultural College.

Brachytarsus Sch.

alternatus Say. Riley county, March, May, June, July, September, "on *Grindelia, Aster* and *Solidago*"; Phillips county; Trego county; St. George, June.

**plumbeus* Lec. Riley county, June.

variegatus Say. Riley county, May, June, July, August; Topeka, August.

CURCULIONIDÆ.

RHYNCHITINÆ

Eugnamptus Sch.

angustatus Hbst. Riley county, May, June.

collaris Fab. Riley county, May, June.

**collaris* var. *nigripes* Mels.. Riley county, May, June.

Rhynchites Hbst.

bicolor Fab. (Common.) Riley county, May, June, July, Sandhills on wild roses; Russell; Topeka; Gove county, July.

**bicolor,* race *alpha* Lec. Topeka.

æneus Boh. Riley county, July, August; Topeka, July; Russell county; Seward county; Trego county; Cowley county, June; Garden City, July.

**mexicanus* Gyll. Topeka, July.

ATTELABINÆ.

Attelabus Linn.

analis Ill. Riley county, May, June, July.

nigripes Lec. Riley county, June, July, August.

rhois Boh. Leavenworth county

PTEROCOLINÆ.

Pterocolus Sch.

ovatus Fab. Riley county, May, June; Topeka, July.

APIONINÆ.

Apion Hbst.

modestum Smith. Topeka; Riley county.

spp. Riley county.

OTIORHYNCHINÆ.

Graphorhinus Sch.

vadosus Say. Riley county, April, May, June; Cowley county.

Epicærus Sch.

imbricatus Say. (Common.) Riley county, June, July; Russell county, June; Cloud county, July; Mitchell county, August; Topeka; St. George, June, July, marsh and swamp land; Conway Springs, September; Leavenworth, June; Winfield, May, in cornfield; Belleplaine, June, injuring young apple trees; western Kansas.

Ophryastes Sch.

vittatus Say. Wallace, July; Meade county, May; Gove county, May; Sharon Springs, October; Ford county, August; Kiowa county, May; Seward county, July; Hamilton county, July; western Kansas.

tuberosus Lec. Grainfield, September; Hurlbart, October; Hamilton county, August; western Kansas.

sp. Logan county, October; Comanche county, July.

Anametis Horn.

granulatus Say (*grisea* Horn). Topeka.

Peritaxia Horn.

hispida Horn. Barber county, July; western Kansas; Manhattan, April.

Tanymecus Sch.

confertus Gyll. (Common.) Riley county, May, June, July, under bark of apple tree; Topeka; Winfield, April; St. George, June; Mankato, June.

Pantomorus Sch. (*Aramigus* Horn).

tesselatus Say. Topeka, July; Trego county; Riley county, June, July, August; St. John, July; Delphos, July; Russell county, June; Seward county, June; St. George, June, July, September; Osborne county, June; Winfield, June; Comanche county, July; Clark county, June.

elegans Horn. Topeka; Riley county, June, August; Meade county, June; Winfield, June.

obscura Horn. Clark county, June; western Kansas.

candida Horn. Wallace county, July.

Aphrastus Sch.

tæniatus Gyll. Riley county, July.

Polydrusus Germ.

americanus Gyll (*Cyphomimus dorsalis* Horn). Riley county, April, June; Topeka.

CURCULIONINÆ.

Sitona Sch.

**hispidula* Fab. Riley county.

lineellus Gyll. Riley county, May, June, July, August; Wichita, July.

Hypera Germ.

punctata Fab. Leavenworth county, June; Independence, May; Manhattan, June.

Phytonomus Sch.

eximius Lec. Riley county, April.

comptus Say. Topeka; Benedict, April; Winfield, April; Manhattan, May.

Listronotus Jek.

caudatus Say. Riley county, June; Topeka.

latiusculus Boh. Topeka.

Hyperodes Jekel (Macrops).

solutus Boh. Topeka; Riley county, June.

Dorytomus Steph.

mucidus Say. Riley county, February, March, April, May, June, September; Elwood, March.

squamosus Lec. Riley county, May.

Desmoris Lec.

scapalis Lec. Winfield, August; western Kansas.

constrictus Say. Riley county, July, August, September; Wichita, April; Topeka, August, September; Cloud county, September; Delphos, July; Winfield, August.

fulvus Lec. Topeka, August; Riley county, July, August, September, on *Helianthus*; Delphos, July; Logan county, August.

Smicronyx Sch.
  **nebulosus* Dietz. Topeka.

Endalus Lap.
  limatulus Gyll. Riley county, May, June; Wallace county, September; western Kansas.

Thysanocnemis Lec.
  fraxini Lec. Riley county, May, August.
  helvolus Lec. Riley county, August; Topeka, August.

Otidocephalus Chev.
  chevrolatti Horn. Riley county, May, July.

Magdalis Germ.
  armicollis Say. Riley county, May, December.
  **salicis* Horn. Riley county, July.

Balaninus Germ.
  **baculi* Chittn. Riley county, September; Norton, August, September.
  nasicus Say. Riley county, June, September, August.
  quercus Horn. Riley county, June, August, September.
  sp. Riley county, May, August, September; Winfield, September.

Orchestes Ill.
  niger Horn. Riley county, April, May, June.
  ephippiatus Say. Riley county, May; Topeka

Elleschus Steph.
  ephippiatus Say. Topeka; Riley county, May, June.

Macrorhoptus Lec.
  estriatus Lec. Winfield, May.

Tachypterus Dietz.
  quadrigibbus Say. Riley county, April, May; Topeka, May; Wathena, May.

Anthonomopsis Dietz.
  mixtus Lec. Riley county, May, bred from plum.

Anthonomus Germ.
  scutellaris Lec. (*Coccotorus scutelluris* Lec.). Riley county, March, April, May, June; Russell county; Meade county, May.
  fulvus Lec. Wallace, July; western Kansas; Winfield, July.
  signatus Say. Riley county, April, June; Topeka.
  nigrinus Boh. Riley county, August.
  albopilosus Dietz. Seward county, June; Ellsworth county, July; Logan county, August; Topeka, August; Riley county, July; west Kansas; Trego county.
  sycophanta Walsh. Topeka.
  squamosus Lec. Riley county, August, September, on *Grindelia;* Logan county, August.
  sp. Riley county, August.

Pseudoanthonomus Dietz.
  **cratægi* Walsh. Riley county, September.

Gymnetron Sch.
  tetrum Fab. Riley county, May, June, July, September; Winfield, May.

Lixus Fab.

**texanus* Lec. Comanche county, July; Topeka, Popenoe; Riley county, July, August; Norton; Dodge City, June.

punctinasus Lec. Riley county, May; Seward county, July; Wichita, April, on dandelion.

terminalis Lec. Riley county, April, June; Norton, Jewell county, June; Rago, June.

mucidus Lec. Riley county, April, May, June; McFarland, June; Osborne, September; Winfield, April.

concavus Say. Riley county, April, May.

musculus Say. Riley county, May, June, July, August; Comanche county, July.

macer Lec. Riley county, July, August

Centrocleonus Lec.

**angularis* Lec. Riley county, sandhills, June.

Cleonopsis Lec.

pulvereus Lec. Riley county, June, August, September.

Cleonus Sch.

trivittatus Say. Western Kansas.

carinicollis Lec. Riley county, July; St. John, July.

**sparsus* Lec. Wallace, July; Clark county, June.

sp. Seward county, July.

Baris Germ.

strenua Lec. Riley county, July, August; Topeka.

transversa Say. Riley county, June.

**subænea* Lec. Riley county, June, August; Wallace, July.

confinis Lec. Topeka, October.

ærea Boh. Riley county; Salina.

**sparsa* Lec. Riley county, August.

pruinosa Lec. Clark county, June; Seward county, June, July.

Onychobaris Lec.

subtonsa Lec. Riley county, May, June; Topeka, May.

pectorosa Lec. Topeka; Riley county, May

Madarellus Casey.

undulatus Say. Riley county, May.

Aulobaris Lec.

**ibis* Lec. Riley county, June.

naso Lec. Riley county, June, August, September, on *Solidago;* Topeka.

**pusilla* Lec. Riley county, August, September, on *Solidago.*

Ampeloglypter Lec.

longipennis Casey. Riley county.

Pseudobaris Lec.

farcta Lec. (Common.) Riley county, June, August, September, on *Salvia, Solidago* and smartweed; Winfield, September; Topeka, July.

**nigrina* Say. Riley county, May, September, October; Winfield, June, on primrose blossom.

angustula Lec. Riley county, June; Topeka.

sp. Riley county, August.

Trichobaris Lec.

trinotata Say. Riley county; Wichita, August.

Orthoris Lec.

crotchii Lec. Western Kansas.

Rhoptobaris Lec.

canescens Lec. Wallace, July; Riley county, June

Centrinus Sch.

penicellus Hbst. Riley county, July.

perscillus Gyll. Russell, June; Comanche county, July.

picumnus Hbst. Riley county, June, July, August, September, on *Polygonum* and *Solidago;* Winfield, September.

Odontocorynus Sch.

scutellum-album Say. Riley county, May, June, July.

Zaglyptus Lec.

**striatus* Lec. Riley county, May.

Gelus Casey (*Piazurus* Sch.).

oculatus Say. Riley county, April, June, August, September; Topeka.

Cylindrocopturus Heller.

operculatus Say. Riley county, June, July.

nanulus Lec. Riley county, June, July.

quercus Say. Riley county, June, July, August; Wallace, July

spp. Russell county, June; Riley county, June

Acanthoscelis Dietz.

acephalus Say. Riley county, June, August; Topeka

Ceutorhynchus Germ.

rapæ Gyll. Riley county, April, May, June, September, on *Polygonum;* Salina; Atchison, May

**cyanipennis* Germ. Riley county, May.

sulcipennis Lec. Riley county, May, June, July, August, September, on *Solidago,* October; St. George, May.

Pelenomus Thom.

**squamosus* Lec. Riley county, August.

Rhinoncus Sch.

pericarpius Linn. Riley county, June, July, August; St. George, June.

pyrrhopus Lec. (Common.) Riley county, May, June, July, September, on *Polygonum;* Winfield, May, June, St. George, May.

Conotrachelus Sch.

nenuphar Hbst. Riley county, April, May, June, July; Topeka, August.

retentus Say. Riley county, June.

affinis Boh. Riley county, June.

seniculus Lec. Riley county, June, July.

nivosus Lec. Riley county, April, June, September.

**arizonicus* Schfr. Riley county, April, May.

adspersus Lec. Topeka; Riley county, July, August, September.

**naso* Lec. Riley county, September.

cribricollis Say. Riley county, May, June; Topeka.

anaglypticus Say. Riley county, June, July, in honey locust pods; Rooks county, August; Winfield, May.

leucophætus Fahr. Riley county, June, July, August, September; Seward county, July; Winfield, July; Kiowa, May; Wallace, July; Topeka.

erinaceus Lec. Topeka.

Rhyssematus Chev.

grandicollis Casey. Riley county, June.

lineaticollis Say. Riley county, June, July; St. George, July; Topeka; Ford county, August; Winfield, May in cornfield, June.

æqualis Horn Riley county, May, June; Clark county, July.

**annectens* Casey Winfield, June, at base of wheat plant.

palmicollis Say. Ford county, August.

Chalcodermus Sch.

æneus Boh. Riley county, June.

**inæquicollis* Horn. "Kan."

collaris Horn. Riley county, August, October

Tyloderma Say.

foveolata Say. Riley county, June, July, August; Topeka, July.

ærea Say. Riley county; Topeka.

Cryptorhynchus Ill.

bisignatus Say Riley county, July.

Gerstæckeria Champ (*Acalles* Sch.)

porosa Lec Wallace county, June, Meade county, May; Dodge City, June, October

Thecosternus Say

humeralis Lec (Common) Riley county, March, April, June, July, August, October; Trego county, November; Wallace county, July; Fort Hays, September; Dodge City, October, Leavenworth county, June, Ellsworth, August; western Kansas

Dryophthorus Sch

americanus Bedel (*corticalis* Say) Topeka.

Cossonus Clairv.

corticola Say Riley county, June, July; Topeka; western Kansas.

Tomolips Woll (*Wollastonia* Horn).

quercicola Boh. "Kansas"; Manhattan, burrows in decaying cottonwood.

CALANDRINÆ

Rhodobænus Lec.

tredecempunctatus Ill. (Common on sunflower.) Riley county, May, June, July, August; Clark county, June; Republic county, July; Canton, September; Topeka, July, Wallace county, July; Ellis county, July; Cloud county, July.

Sphenophorus Sch.

vomerinus Lec. Mitchell county, August; western Kansas; Wallace county, July.

ochreus Lec. Lincoln; Riley county, June; western Kansas; Altoona, June; Atchison, June, "feeding on wheat fields."

pertinax Oliv. Western Kansas.

robustus Horn. Western Kansas.

**striatipennis* Chittn. Western Kansas.

maidis Chittn. Wichita, injuring corn, July; Winfield, February, April, May, June, July, August, September; Dexter, July, November; Arkansas City, May, June, July.

melanocephalus Fab. Riley county, June.
venatus Say. Riley county; St. George, June.
parvulus Gyll. Riley county, April, May, June; Johnson county, "May, working on corn."
destructor Chittn. Manhattan, June.
zeæ Walsh. Gardner, "working on corn."
callosus Oliv. Manhattan, July; St. George, July.
cultellatus Horn. Riley county, June, July, August, September; Rooks county, August.
compressirostris Say. Wallace county, July.
**minimus* Hart. Riley county, March, May.
germari Horn. Kiowa county, May; Manhattan, July.

Calandra Clairov.
oryzæ Linn Riley county, February, August; Johnson county, November; Topeka; Winfield, August, on sunflower.
granaria Linn. Riley county, April, June; Hoxie, August

SCOLYTIDÆ.

SCOLYTINÆ.

Scolytus Geoff.
quadrispinosus Say. Topeka, June, July; Riley county, August, in bitternut.
muticus Say. Riley county, May in hackberry, June in hackberry.
rugulosus Ratz. Cherokee, September; Wilder, August in apple.

IPINÆ.

Xylocleptes Ferran.
**cucubitæ* Lec. Ashland, June

Xyleborus Eich
xylographus Say Topeka.

Phloeosinus Chap.
dentatus Say Salina, March, mines in red cedar.

Hylesinus Fab.
aculeatus Say. Riley county, April, June, under bark in green ash

Helium as a Balloon Gas.

HAMILTON P. CADY.

Helium being an absolutely inert gas chemically, and yet much lighter than air, is obviously an ideal balloon gas, provided it can be obtained in sufficient quantities at a reasonable figure and if it will stay in a balloon.

Helium is twice as dense as hydrogen, and hence has less lifting power, but not as much less as this ratio would indicate. One gram of hydrogen displaces 14.39 grams of air, and therefore will lift itself and 13.39 other grams, while 2 grams of helium will lift 12.39 grams in addition to itself; so the flotation of helium is 92½ per cent of that of hydrogen.

The question of the ability of balloon fabric to retain helium was one which gave much concern. Hydrogen escapes at a fairly rapid rate, and since helium is able to diffuse through hot quartz glass much faster than hydrogen, it would not be impossible for it to pass through balloon fabric as fast or faster than

hydrogen, and this would be very serious, because helium inevitably costs more than hydrogen. Fortunately, it turned out that helium escaped only about half as fast as hydrogen.

The question of its availability, then, turns on its production in sufficient quantities at a low enough price. A little over twelve years ago Dr. David McFarland and I found that the almost noninflammable gas of the Dexter, Kan., field contained 1.84 per cent of helium, and since there were many wells each able to yield ten million cubic feet per day, here was an abundant source of the gas. We made an extensive investigation of other gases of this country and Canada and concluded that all natural gases contain some helium, but nowhere have gases been found as rich as those of the midcontinent field, especially certain portions of Kansas.

When our country entered the war the British government suggested that our government take up the problem of obtaining helium for balloons. The British were then at work trying to use the comparatively poor gases of Canada The problem was apparently a simple one and could be solved by the same methods used for the separation of oxygen, nitrogen and argon from the air. In fact, in some ways it should be easier, because the difference in boiling points is greater. Helium boils at —268.5° C., while the nitrogen and methane which accompany it boil at —195° and —164°, respectively. In the air the boiling points are· oxygen, —182.5°; nitrogen, —195°; and argon, —186°. We were able to point out to those interested that the problem was complicated by the fact that, in our experience, helium is fairly easily soluble in liquid natural gas, and that this would have to be taken into account.

As the result of conferences in Washington the main problem was assigned to the Bureau of Mines, and by them apportioned to those who seemed best prepared to handle their "bit" The University of Kansas was asked to do the analytical work involved in the location of the most available source; to determine the solubility of helium in liquid methane, in liquid nitrogen, and in mixtures of the two, to prepare helium for the Bureau of Standards to use in the test of its permeability through balloon fabric (we later also made some experiments along this line); to determine the density of the helium as prepared, to see if the neon which was always present had an appreciable effect on its flotation, and also to determine how much hydrogen might be present in the gas without forming an inflammable mixture.

We found that the best available source which was ready developed and in use on a large scale was the wells at Petrolia, Tex., supplying Fort Worth. These ran 0.96 per cent, much lower than the Dexter, Kan., gas, but that supply was exhausted. The solubility was found to be so great that one-third or more would be lost if efficient fractionation were not arranged for in the process. Neon was present in too small quantities to appreciably affect the flotation. Ten per cent of hydrogen could be mixed with the helium without making a gas which could be ignited.

The Air Reduction Company and the Linde Air Products Company were asked to install experimental plants at Fort Worth to try to separate the helium. They did so. The Air Reduction Company uses the Claude process, which seems to lack the flexibility necessary for experimental purposes, and they were not successful in making concentration of helium. The Linde plant, after many changes, did produce highly concentrated helium in fairly large

quantities at a cost of about $100 per thousand cubic feet. The Navy Department is now erecting a large plant to extract helium by the Linde process.

A third experimental plant has been erected at Petrolia, using a process worked out by Norton, a brilliant engineer with a very thorough knowledge of thermodynamics. His process is theoretically sound, but he had never been able to finance its development Norton is a protégé of Cottrell, of the Bureau of Mines, and the latter insisted that Norton be given money to erect a plant. This is now in operation, and while it has as yet produced helium of no higher concentration than 16 or 17 per cent, its workings are being continually improved and the indications are that it also will be successful. The encouragement of the Norton process is Cottrell's chief contribution to the helium problem. Another man who contributed largely to the success of the undertaking was G. O. Carter, of the Navy Department, Bureau of Steam Engineering. He had formerly been associated with the Linde company, and I believe that his advice and experience were most helpful Burrell, as head of the American University experiment station, had general charge of the whole problem, and was very efficient; but the man to whom probably the most credit belongs is Sir William Ramsay, who first suggested the use of helium for this purpose.

In our laboratory my chief assistant was C W Seibel H C. Allen, P. V. Faraghar, F. W Bruckmiller and Emily Berger were also very active in the matter.

The Earth-Moon Theory.

LeRoy Hughbanks

GENERAL INTRODUCTION

Before beginning our discussion of the earth-moon theory it will perhaps be profitable for us to survey briefly a few general facts and characteristics of our moon.

In the following table the volume, surface, mass and density of the earth equals one.

TABLE OF THE MOON

Siderial period	27 days, 7 hours, 43 minutes
Distance fom the earth	237,300 miles
Diameter	2,160 miles
Surface	0.074
Volume	0 00234.
Mass	0 0128
Density	0.63
Axial rotation	27 days, 7 hours, 43 minutes
Force of gravity (fall)	2 48 feet in 1 second.
Velocity in orbit	2,273 miles per hour

The moon has always been an object of beauty and interest in the nightly heavens. To the naked eye she presents a soft, silvery luster, and many are they who in ages past have worshiped at her shrine. Old Omar of the East paid homage to her in his poetry, and many another in later days have sung of her transcendent glory.

There are a few mountain chains, hundreds of hills and valleys—numerous systems of radiating streaks—and over thirty thousand ring mountains of all sizes from a mile in diameter to sixty times that.

All details of the lunar surface have been mapped and named. Hevelius (1611-'87), of Danzig, made the first map of the moon, and Schmidt (1825-'84), of Athens, the last. The recent photographic atlases of the Lick and Paris observatories show the lunar surface very satisfactorily, and Ritchey (1864) attained even greater success with the Yerkes telescope. Changes on the moon, if at all, are on a very small scale—too minute for detection with present instruments.

HISTORY OF TREATMENT.

The first treatment of the moon was empirical, but the second treatment was founded on the law of gravitation. The modern history of the moon begins with that illustrous natural philosopher, Sir Isaac Newton. Hipparchus left us a considerable amount of valuable data concerning the motion of the moon The work of his predecessors did not embrace more than the mean motion of the moon and its nodes Hipparchus made the following valuable discoveries.

1. The eccentricities of the moon's orbit
2. Motion of the perigee and apogee.
3. The numerical determination of the elements of the moon's motion.

The discovery of eviction was made by Ptolemy

As was stated above, the modern lunar theory commenced with Newton, and consists in determining the motion of the moon deductively from the theory of gravitation.

He explained "The elliptic motion of two mutually attracting bodies round their common center of gravity" by geometrical constructions. The problem was one of determining the variations from the elliptical motion which would be produced by a third body Such constructions could lead only to approximate results. This was left for pure mathematicians and was a problem of pure algebra.

THE EARTH-MOON THEORY.

"The moon," says Prof. Percival Lowell, "did not originate as a separate body, but had its birth in a rib of earth." Doctor Lowell is an ardent supporter of "the earth-moon theory," and his views and deductions are frankly stated in his two last scientific works, "Mars as the Abode of Life" and "Evolution of Worlds," both of which are publications of the Macmillan Company, New York.

Prof. E. C. Pickering, of Harvard College observatory, says "If we were to observe the earth from a point in space one thousand miles northeast of New Zealand, the land area surrounding the spot would appear nearly circular."

Mr. William Thayer Jordan, in an article entitled "The Form of the Earth," *Scientific American Supplement,* December 14, 1912, is of the opinion, however, "that the advocates" of the "earth-moon theory" had better look for evidence of the moon's detachment on the highlands of Tibet rather than from the Pacific ocean.

Lord Kelvin and Sir George Darwin have long held that the moon had a terrestrial origin. The publication of their many papers and memoirs along this line of research are some of the most exquisite pieces of scientific literature ever given to the technical world.

Prof. Thomas C. Chamberlain, of the University of Chicago, in his excellent lecture on "The Evolution of the Earth," states that the mathematical calcu-

lations of Mr. Darwin are trifling, though we must confess that if this be true they have stood the test of scientific investigators for many decades. For a clear satement of the views held in regard to the moon's origin by Prof. George Darwin we will quote from the last two paragraphs of his celebrated work on "Tides":

"INFLUENCE OF TIDAL FRICTION ON THE EVOLUTION OF THE SOLAR SYSTEM.

"According to the nebular hypothesis, the planets and the satellites are portions detached from contracting nebulous masses. In the following discussion that hypothesis will be accepted in its main outline, and we shall examine what modifications are necessitated by the influence of tidal friction. It may be shown that the reaction of the tides raised in the sun by the planets must have had a very small influence in changing the dimensions of the planetary orbits round the sun. From a consideration of numerical data with regard to the solar system and the planetary subsystems it appears improbable that the planetary orbits have been sensibly enlarged by tidal friction since the origin of the several planets, but it is possible that some very small part of the eccentricities of the planetary orbits is due to this cause. From arguments similar to those advanced with regard to the solar system as a whole, it appears unlikely that the satellites of Mars, Jupiter and Saturn originated very much nearer the present surfaces of the planets than we now observe them; but the data being insufficient, we cannot feel sure that the alteration of the dimensions of the orbits of these satellites has not been considerable It remains, however, nearly certain that they cannot have first originated almost in contact with the present surfaces of the planets, in the same way as in the preceding sketch, and has been shown to be probable with regard to the moon and earth. Numerical data concerning the distribution of moment of momentum in the several planetary subsystems exhibit so striking a difference between the terrestrial system and those of the other planets that we should from this alone have grounds for believing that the modes of evolution have been considerably different The difference appears to lie in the genesis of the moon close to the present surface of the planet, and we shall see below that solar tidal friction may be assigned as a reason to explain how it has happened that the terrestrial planet had contracted to nearly its present dimensions before the genesis of a satellite, but that this was not the case with the exterior planets. The efficiency of solar tidal friction is very much greater in its action on the nearer planets than on the further ones The time, however, during which solar tidal friction has been operating on the external planets is probably much longer than the period of its efficiency for the interior ones, and a series of numbers proportional to the total amount of rotation destroyed in the several planets would present a far less rapid decrease as we recede from the sun than numbers simply expressive of the efficiency of tidal friction at the several planets. Nevertheless it must be admitted that the effect of solar tidal friction produced on Jupiter and Saturn has not been nearly so great as on the interior planets; and, as already stated, it is very improbable that so large an amount of momentum should have been destroyed as to materially affect the orbits of the planets round the sun."

We will now examine how the differences of distance from the sun would be likely to affect the histories of the several planetary masses. According to the nebular hypothesis, a planetary nebula contracts, and rotates quicker as it contracts. The rapidity of the revolution causes it to become unstable, or perhaps an equatorial belt gradually detaches itself. It is immaterial which of these two really takes place. In either case the separation of that part of the mass which before the change had the greatest angular momentum permits the central portion to resume a planetary shape. The contraction and the increase of rotation proceed continually until another portion is detached, etc. There thus reoccur at intervals a series of epochs of instability or of abnormal change. Now tidal friction must diminish the rate of increase of

rotation due to contraction, and therefore if tidal friction and contraction are at work together the epochs of instability must reoccur more rarely than if contraction alone acted. If the tidal retardation is sufficiently great the increase of rotation due to contraction will be so far counteracted as never to permit an epoch of instability to occur.

Since the rate of retardation due to solar tidal friction decreases rapidly as we recede from the sun, these considerations accord with what we observe in the solar system. For Mercury and Venus have no satellites, and there is a progressive increase in the number of satellites as we recede from the sun. Moreover, the number of satellites is not directly connected with the mass of the planet, for the earth has relatively by far the largest satellite of the whole system. Whether this be the true cause of the observed distribution of satellites amongst the planets or not, it is remarkable that the same cause also affords an explanation, as we shall now show, of that difference between the earth with the moon and the other planets with their satellites which has caused tidal friction to be the principal agent of change with the former but not with the latter.

In the case of the contracting terrestrial mass we may suppose that there was for a long time nearly a balance between the retardation due to solar tidal friction and the acceleration due to contraction, and that it was not until the planetary mass had contracted to nearly its present dimensions that an epoch of instability could occur It may also be noted that if there be two planetary masses which generate satellites, but under very different conditions as to the degree of condensation of the masses, the two satellites will be likely to differ in mass. We cannot, of course, tell which of the two planets would generate the larger satellite Thus, if the genesis of the moon was deferred until a late epoch in the history of the terrestrial mass, the mass of the moon relatively to the earth would be likely to differ from the mass of the other satellites relative to their planets If the contraction of the planetary mass be almost completed before the genesis of the satellites, tidal friction, due jointly to the satellites and to the sun, will thereafter be the great cause of change in the system; and thus the hypothesis that it is the sole cause of change will give an approximately accurate explanation of the motion of the planet and satellite at any subsequent time. We have already seen the theory that tidal friction has been the ruling power in the evolution of the earth and moon coordinates the present motion of the two bodies and carries us back to an initial state when the moon first had its separate existence as a satellite; and the initial configuration of the two bodies is such that we are led to believe that the moon is a portion of the primitive earth detached by rapid rotation or other causes. There seems to be some reason to suppose that the earliest form in which the moon had a separate existence was as a ring or chain of meteorites; but this condition precedes that to which the dynamical investigation leads back.

Let us now turn to the other planetary subsystems. The satellites of the larger planets revolve with short periodic times. This admits of a simple explanation, for the smallness of their masses would have prevented tidal friction from being a very efficient cause of change in the dimensions of their orbits, and the largeness of the planets' masses would have caused them to proceed slowly in their evolution. If the planets be formed from change of meteorites

or of nebulous matter, their rotation has arisen from the excess of orbital momentum of the exterior over that of the interior matter. As we have no means of knowing how broad the chain may have been in any case, nor how much it may have closed in on the sun in course of concentration, we are unable to compute the primitive angular momentum of a planet. A rigorous method of comparison of the primitive rotation of the several planets is thus wanting. If, however, the planets were formed under similar conditions, then we should expect to find the exterior planets now rotating more rapidly than the interior ones. On making allowance for the different degrees of concentration of the planets, this is the case. That the inner satellites of Mars revolve with a period of less than a third of the planet's rotation is perhaps the most remarkable fact in the solar system. The theory of tidal friction explains this perfectly, and this will be the ultimate fate of all satellites, because the solar tidal friction retards the planetary rotation without directly affecting the satellites' orbital motion. Numerical comparison shows that the efficiency of solar tidal friction in retarding the terrestrial and Martian rotation is of about the same degree of importance, notwithstanding the much greater distance of the planet Mars. In the above discussion it will have been apparent that the earth and moon do actually differ from the other planets to such an extent as to permit tidal friction to have been the most important factor in their history

By an examination of the probable effects of solar tidal friction on a contracting planetary mass we have been led to assign a cause for the observed distribution of satellites in the solar system, and this again has itself afforded an explanation of how it happened that the moon so originated that the tidal friction of the lunar tides in the earth should have been able to exercise so large an influence We have endeavored not only to set forth the influence which the tidal friction may have, and probably has had, in the history of the system, if sufficient time be granted, but also to point out what effects it cannot have produced. These investigations afford no ground for the rejection of the nebular hypothesis; but while they present evidences in favor of the main outlines of that theory, they introduce modifications of considerable importance. Tidal friction is a cause of change of which Laplace's theory took no account; and although the activity of that cause may be regarded as mainly belonging to a later period than the events described in the nebular hypothesis, yet it seems that its influence has been of great and in one instance of even paramount importance in determining the present condition of the planets and their satellites. Throughout the whole of this discussion it has been, however, supposed that sufficient time is at our disposal. Sir W. Thomson and others have, however, adduced reasoning which goes to show that the history of the solar system must be comprised within a period of considerably less than a hundred million years. It would perhaps be permature to accept this as the final and definite conclusion of science. If, however, it be confirmed, we shall only be permitted to accept the doctrine that tidal friction has effected considerable modification in the configuration of the moon and earth, and must reject the earlier portion of the history sketched above.

There is another scientific school that holds the moon had a separate origin from that of the earth. Perhaps chief among these gentlemen is Prof. T. J. J. See, United States government astronomer, but he is not alone in his contentions. We also find listed among the adherents of this theory Mr. William

Thayer Jordan; Prof. Henri Jules Poincare, of the University of Paris, who used Doctor See's scholarly work, "Researches on Cosmical Evolution," volume 11; Mr. William Huggins, former president of the Royal Society; and Professor Strongen, of Copenhagen.

In an address delivered before the California Academy of Science, August 7, 1911, Professor See had the following to say in regard to the origin of the moon

"THE CAPTURE OF THE MOON BY THE EARTH.

"The case of the terrestrial moon is of special interest, because it is relatively by far the largest of our satellites and was formerly supposed by Lord Kelvin and Sir George Darwin to have had an exceptional origin. But it was shown by me in 1909 (A. N., No. 343) that the moon was formed like the other satellites, and is in fact a planet which the earth captured from space, just as the other satellites were captured by their several planets. We shall not here go into the details of the moon's origin, beyond pointing out the reasons why a terrestrial origin of the moon is impossible.

"(1) The rupture of the earth's figure of equilibrium, which Darwin assumed to account for the origin of the moon, postulates a primitive rotation in less than three hours, or nine times faster than at present. From the causes which produce planetary rotations, as set forth above, we know that no such rapid rotation could have existed in the case of the earth

"(2) Even if such rapid rotation had existed, the matter detached from the earth would have taken the form of a swarm of small bodies, and these meteorites never could have united into one mass, as now observed in our actual moon

"(3) The satellites of the other planets are recognized to be captured bodies, and the same process naturally will have operated in giving the earth a satellite, even if it is of exceptionally large mass. It should be especially noted that the large mass presents no difficulty to the capture theory. The anomaly lies in the small size of the earth, since several of the satellites of Jupiter and Saturn are fully as large as the moon, while those of Uranus and Neptune are not enormously smaller.

"(4) In Darwin's celebrated graphical method for tracing the moon back to the earth, it is found to be impossible to bring the two globes close together, because at nearest approach a space of over 4,000 miles intervenes between the surfaces which cannot be bridged over. This contradiction to the terrestrial theory indicates that it is vitiated by an error, and must be unconditionally given up. For these four weighty reasons we conclude that our moon can be nothing else than a planet which came to us from the heavenly spaces. It follows also that the earth always did rotate in about the same time as at present, and has never suffered retardation from about three hours, as Darwin inferred. This simplifies very considerably many problems of geology, and brings the cosmogony of the earth and moon into harmony with that found in the rest of the solar system and in the sidereal universe.

"THE ORIGIN OF THE LUNAR CRATERS AND MARIA.

"Ever since Galileo's discovery of the mountains on the moon it has been a problem for astronomers to explain the craters and other phenomena on the lunar surface. Notwithstanding the fact that the lunar craters are totally different from those on the earth, it has been believed until very recently that they had a volcanic origin. It turns out, however, that the lunar craters are due to impact of smaller bodies against the lunar surface; and this explains the sunken character of the craters, which are all below the normal level of the lunar surface; the small volume of the walls in comparison with the crater basins; the steepness of the inner walls, while the outer ones have a more gradual slope; the central peaks, which are residues of the satellites that produced the craters; the superposition of one crater over another; and many other phenomena which show that impact and not volcanic

action has produced the mountains on the surface of the moon. In the same way it is shown that the *maria* are due to conflagrations which have melted down to a dead level considerable areas of the lunar surface, only the more prominent walls here and there surviving as ghost craters. It is a very remarkable fact that can scarcely escape the notice of the sagacious historian of the future, that prior to my work on 'Earthquakes and Mountain Formation' (Proc. Am. Philos. Soc., Philadelphia, 1906-'08), terrestrial mountains were erroneously explained by secular cooling and contraction of the earth, whereas they are really formed by the leakage of the oceans and the expulsion of lava under the land, and the mountain ridges, therefore, run as great walls along the border of the ocean, as in the typical case of the Andes in South America The current explanation of terrestrial mountain formation was thus erroneous. The new theory that our mountains are formed by the sea has, however, already been very generally accepted. On the other hand, the lunar craters were supposed to be of a volcanic origin, whereas they really were due to impact. Thus, wonderful as it may seem, the causes assigned in both cases were erroneous. Besides the evidence of general character above cited, the theory as to the origin of the lunar craters by impact now rests on an absolute proof of mathematical kind, as follows It is shown by the researches of Lehman-Filhe's (A. N , 3479-3490) and Strongen (A. N., 3897) that increase of the central mass of the planet by the downfall of cosmical dust will decrease the mean distance of the satellites, but not the eccentricities of its orbit. It is shown in my researches (volume 2, 1910) that the eccentricity can be diminished only by the action of a resisting medium such as operated in the capture of the satellites. As the eccentricities of the satellites' orbits usually are evanescent, and it is shown that they have been destroyed by the action of a resisting medium, we should expect the moon surface to bear witness to this process of cosmical bombardment by which the orbits of the satellites have been rounded up. Thus indentations analogous to the lunar craters ought to exist, and as they are all of one type their origin must be assigned to the impact of smaller satellites against the lunar surface. Our proof of the origin of the lunar craters is therefore essentially an absolute proof which admits of no dispute. If it be asked why indentations similar to the lunar craters were not produced on the earth, our answer is that such terrestrial craters due to impact did exist before geological history began, but they have since been quite obliterated by the effects of the oceans and atmosphere, while modern terrestrial mountains of a totally different type have since been developed along the borders of our seas by the leakage of the oceans. These manifold errors afford us an impressive warning as to the worthlessness of traditional opinion, because so much of our reasoning in physical science heretofore has been based on a false premise. Finally, it may be remarked that the satellites of Jupiter and Saturn are variable, as if covered by *maria* like our own moon, so that the conflagrations which melted areas and produced *maria* on our satellite have also occurred elsewhere in accordance with the requirements of this simple theory."

As can readily be seen, the astronomical world is at variance on this subject, men of learning and serious scientific attainment on either side contending for the particular bulk of evidence which they feel will insure a correct solution of the problem. Dr. Kennedy Duncan, for a number of years at the University of Kansas, thought "the planetisimal hypothesis," as carefully worked out by Prof. T. C. Chamberlain and Dr. Horace Moulton, would give us a satisfactory solution to the origin of the sun, planets and satellites. The work of these men has been very productive and we will await with much interest their further research.

A Study of the Oil from Sumac (Rhus glabra).

H. W. Brubaker.

Since the demand for fats has increased so greatly and their price has reached such a high level it has become imperative that we make use of all the available sources of this most important material. A great deal of the rocky waste land of Kansas and other states is covered with the common sumac (*Rhus glabra*). It occurred to the author to make a chemical study of the oil from the sumac seed to determine its fitness as a food or for industrial purposes, and the amount available.

The berries from which this oil was obtained were gathered at Manhattan, Kan., in February, 1919. The husks were removed from the berries by rubbing gently in a mortar and sending the material through a small fanning mill. The clean, air-dried seeds were ground in a mill and the fat extracted with dry ether in a continuous extraction apparatus large enough to hold two or three pounds of the material. Two determinations gave an average of 11.71 per cent of oil in the ground seeds. Table No. I summarizes the results of the physical and chemical examination of the oil

TABLE No I

Determination number.	Sp. gr. at 150° C.	Index of refraction at 20° C. Abbe's refractometer.	Acid value.	Acetyl value	Saponification number.	Iodine value.	Per cent of soluble fatty acids.	Per cent of insoluble fatty acids.
1	0 92568	1 4710	0 9	9 27	193 2	126 55	0 85	92 68
2	0 92587	1 4710		9 20	193 8	126 98	0 67	93 55
3		1 4710			190 8		0 78	94 38
Average.	0 92577	1 4710	0 9	9 235	192 6	126 76	0 766	93 54

Table II gives the characteristics of the insoluble fatty acids·

TABLE No. II.

Melting point.	Solidification temperature.	Index of refraction.	Iodine value.
17° C.	6° C.	1 47°	121 8

The oil of sumac has a mild odor, pleasant taste and a deep yellow color. It is quite viscid at ordinary room temperature. Upon being cooled it thickens gradually until at —16° C. it has the consistency of soft vaseline. I did not cool the oil to its freezing point. G. B. Frankforter and A. W. Martin give the freezing point of the oil from *Rhus glabra*, gathered in Minnesota, as —24° C.*

* The American Journal of Pharmacy, vol. 76, p. 151; April, 1904.

These authors also found an iodine value of 87, which differs materially from that found for the Kansas oil, 126.76, shown in table I. The high iodine value would indicate that the oil should have fairly good drying qualities. This conclusion is substantiated by the results of comparative tests shown in table III:

TABLE No. III.

Oil Tested.	Percentage increase in weight in 7 days of a thin film of oil.	Rise in temperature on treatment with concentrated sulphuric acid.	
		Initial temperature.	Highest temperature.
Linseed oil	9 30	20° C.	94° C.
Sumac oil	1 66	20° C.	70° C.
Cottonseed oil	65	20° C.	55° C.

A small amount of the oil mixed into a paste of the consistency of paint with sublimed white lead, and spread on a plate of glass, dried completely in three days.

It seems fair to conclude from the above study that sumac oil compares favorably with other vegetable oils, such as cottonseed oil and corn oil, in its chemical properties. It might readily find a use as an edible oil or in the soap-making industry, or as a semidrying oil in the paint industry, if it can be put on the market at a reasonable cost. Whether this can be done or not can be answered only by some vegetable-oil manufacturer becoming interested enough in the proposition to make a bid for the shipment of the seed.

PART III.

PAPERS—FIFTY-SECOND ANNUAL MEETING.

TITLES OF PAPERS,
FIFTY-SECOND ANNUAL MEETING.

Some Factors in Agricultural Cost Productions. *I. D Graham and T D Hammatt*

Standards of Purity for Medicinal Agents *L E. Sayre*

Botanical Notes, 1919-1920. *Frank U. G. Agrelius.*

A Preliminary List of Insects of the Sorghum Field *Wm P. Hayes.*

How to Determine Altitudes Satisfactorily With an Aneroid Barometer. *J. E. Todd.*

Archæological Notes on Pine River Valley, Colorado, and the Kayenta-Tuba Region. *Albert B. Reagan.*

A List of the Cicadellidæ of Kansas. *P B Lawson.*

A List of the Grasses of Douglas County. *P. B. Lawson.*

Field Work in Kansas and Texas *Charles H. Sternberg*

Education Physical and Mental. *J. M. McWharf.*

Fossils from the Western Front. *Frank P. Strickland, Jr.*

An Annotated List of Some Kansas Pleurosticti (Scarabæidæ) *J W. McCulloch and W. P. Hayes.*

A Preliminary Study of the Life History and Habits of Dione Vanillæ *Vance Randolph.*

A Kitchen Disinfectant. *F. A. Patty and L. E. Sayre*

Plant-disease Survey Report for Kansas, 1919 *L. E. Melchers*

Some Factors in Agricultural Cost Production.

I D GRAHAM and T. D. HAMMATT

The earliest known record of the gathering of statistical information dates back to the year 3050 B C., and the use and value of such knowledge has been growing since. It is only within the last half century, however, that the proper system of dealing with large numbers, or of numbers gathered from numerous sources, has really attained the dignity of science.

The value and application of this new science has been brought home to the people of this country in recent years with a force which has rendered it of very high economic importance. During the war period, when it became necessary to fix the price of wheat and other agricultural commodities, it was found that the necessary knowledge to do this was lacking Although wheat is the oldest crop known to man, no one knew what the cost of production might be for any large area, and such knowledge was vital.

MODERN STATISTICS.

One of the most valuable characteristics of modern scientific statistics lies in the fact that it gives us a sufficiently accurate picture of a group of objects without going through the laborious and expensive process of a complete enumeration of all the items in the group Thus it is by no means necessary in ascertaining average cost of producing an acre or bushel of wheat to obtain complete data in regard to each acre or every bushel

If a considerable number of typical instances can be obtained and properly arranged, the difference from the true average value per acre or per bushel of all the acres or bushels in the state will be so small as to be, for all practical purposes, of no importance

The anthropologist discovers the physical characteristics of a tribe or race by making careful measurements of only a small minority of the whole. If two persons were blindfolded and required to pick several hundred apples from a bin containing a million, the average weight of the selected groups of apples would equal each other, although the apples might vary considerably in size. Not only this, but the average weight of all of the selected apples would be the same as that of the larger number remaining in the bin.

This fact is based on a law of nature which is formulated in the mathematical theory of probabilities. Under this theory a moderately large number of items taken at random from among a very large group is practically sure, on the average, to have the characteristics of the larger group. This is the law upon which the whole system of life insurance is based, and while it is not claimed that these results are mathematically exact, it is emphatically stated that they are sufficiently accurate for all practical purposes, and are so used in large business enterprises generally as well as in the scientific work of such men as Luther Burbank.

TWO METHODS.

There are two methods of applying this law in the gathering and use of agricultural statistics. The first is called a "survey," and attempts a minute analysis by experts of a single farm or a small group of farms which are considered typical. Upon this method have been based the efforts made by governmental and other agencies to secure desired information upon the cost

of production and other necessary facts regarding farm crops and management. Generally speaking, the results obtained under this method have been sufficiently accurate to give a fair idea of the approximate cost, but this method lacks in that it cannot show results which are typical of areas so large as a state or a region where information concerning the dominant crop is sought.

The second method is by means of the "questionnaire," through which every county in the state is covered and the assembled replies averaged in detail, so that an accurate picture of the customs, methods and costs of that state is shown. Through this method accuracy is secured by covering enough farms in all parts of the state to insure an average which shall be typical. Through it a wider field may be covered than by the survey, and there is a great saving of time. The expense of collecting information by this means is very much less, and such information has the merit of uncolored farm facts received at first hand.

Under the conditions engendered by the World War and the succeeding reconstruction period the wheat crop has assumed a previously unknown importance, and the Kansas State Board of Agriculture became the leader in an investigation of the methods and costs of production of this crop, which is the first real effort, with which we are familiar, of any large class of producers, manufacturers or distributors to show the exact cost of services rendered. Haphazard inquiries as to the cost of producing a farm crop have usually brought replies which vary widely and have given rise to the impression that the farmers do not know their business. By the use of the questionnaire method, Secretary J C. Mohler, of the Kansas State Board of Agriculture, has not only determined that while many farmers will hesitate when asked to give accurately the cost per bushel or per acre of producing wheat or other crops, they do really know their business and can give accurate statements of fact as to the items which make up the cost of production.

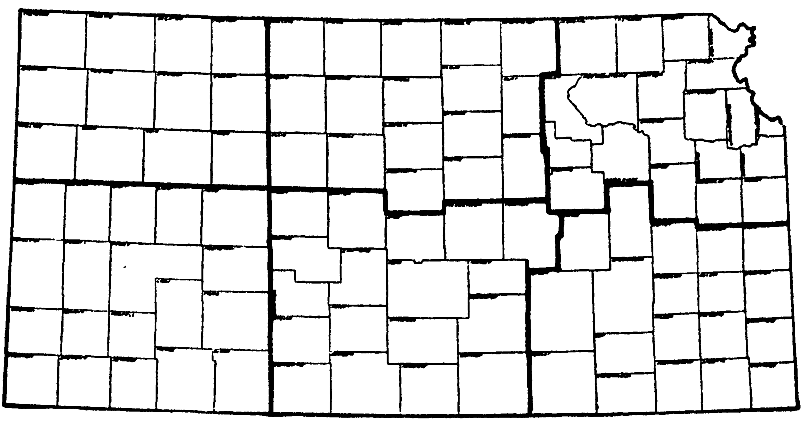
It is very often true that the cost of production of an acre of wheat on one farm will greatly exceed that upon an adjoining farm, and every item in the cost account of each farm be accurate and within the limits of economic farm practice. It is also true that there will be a marked variation in the cost of wheat raised on the large acreage of the farmer who specializes in this crop and has the necessary equipment with which to handle it, when compared with that produced on a farm where wheat is only an element in a regular rotation of crops or where it is incidental to a necessary change of crops.

In sending out some 10,000 questionnaires to the wheat-growing farmers of Kansas, Secretary Mohler did not ask the farmers to give their answers in lump sums, as this would have resulted in a confusion of replies, due to the fact that very few of these farmers are in the habit of keeping accounts in such detail as to furnish the desired information.

THE FARMER HAS KNOWLEDGE.

The farmers do, however, have exact knowledge of the various items which should enter into such an average as was sought, and by adapting the method of questioning to the habits of thought of the farmers and the character of the information which it was known they could furnish, Secretary Mohler was able to acquire and have analyzed a vast amount of information, the sum total of which comprises exactly what was desired.

As an illustration it may be stated that in the analyses of the replies the state was divided into sections, as shown by the accompanying map, and the details worked out for each section, and then the whole was correlated for the state. This was done because it was found that for the purpose of this investigation the conditions and methods of production were so similar in every case that the section was the smallest unit necessary. The facts and figures obtained for any section are applicable to every county in that section. It was also found that the variation in methods and the consequent cost occurred from east to west, according to the amount of rainfall, and that only slight variations occurred from north to south in the state, where the difference in rainfall is less apparent.



If throughout a given division conditions and methods of production are similar, the average cost of production in the northern and southern sections of the division must be similar, and if the averaged replies from several hundred farmers in each division are similar, strong evidence is afforded of the essential accuracy of their replies. The reports received from farmers coöperating in this investigation present such evidence. This may be shown clearly by a few examples:

	Seed wheat — *Pecks per acre*	*Seed wheat* — *Price per bu*	*Machinery, charge per acre.*	*Horses* — *Charge per year.*	*Horses* — *Days used per year.*
Eastern division					
Section A	5.3	$2.24	$1.99	$162	165
Section B	5.2	2.19	1.83	153	173
Central division.					
Section C	4.6	2.24	1.72	130	155
Section D	4.2	2.23	1.83	131	153
Western division:					
Section E	3.3	2.14	1.21	121	154
Section F	3.1	2.21	1.25	132	156

	Preparing the seed bed, cost per acre.	*Harvesting, cost per bu.*	*Threshing, cost per bu.*
Eastern division:			
Section A	$3.74	27.1¢	31¢
Section B	4.08	26.3	32
Central division:			
Section C	2.80	29.5	30
Section D	2.75	27.0	31
Western division:			
Section E	2.00	22.7	30
Section F	2.27	23.0	28.6

The 2,040 wheat growers whose statements were used in compiling the cost data represent every county in the state and include both landowners and tenants, and small as well as large producers. Their aggregate experience in wheat growing in Kansas covers 31,792 years and the area of their farms is 491,062 acres. From these sources have been derived the necessary facts which have resulted in a determination of the cost of production of wheat in Kansas.

The average cost of producing an acre of wheat in Kansas for the crop of 1919, and the average return per acre from wheat sold to December 1, as reported by Kansas farmers, was as follows

The state		
Cost per acre	$25 20	
Return per acre	24 77	
Loss per acre		$0 43
Eastern division		
Cost per acre	$33 75	
Return per acre	33 60	
Loss per acre		15
Central division		
Cost per acre	$24 60	
Return per acre	23 08	
Loss per acre		1 52
Western division		
Cost per acre	$18 60	
Return per acre	20 46	
Gain per acre		1 89

These amounts show that there was a loss to the farmers of Kansas on the crop of 1919, but these amounts do not show the full extent of this loss, because it is impossible to express in exact figures and to include in the expense account certain factors, stated hereafter, by which the wheat grower is materially affected.

If the return from the crop had been exactly equal to the cost as computed in this investigation, the farmer would have received—

A moderate rate of interest (5 per cent) for the use of capital represented by land, buildings and equipment used for wheat.

The going wage of a farm hand for his labor, or for the greater part of the time devoted to wheat—$55 a month and board.

A compensation of $2.50 per day for his services as a manager for the time devoted to wheat, averaging 97 days.

Sufficient allowances to cover necessary repairs and replacements.

One-third his house rent.

Some protection against crop failures through charging to the acres harvested the cost of seed and seeding for acres abandoned annually.

But the return from the crop failed to afford such compensation as this by the amount already stated; and further, in calculating the cost of the crop in this investigation the farmer has been allowed—

Nothing for the loss of fertility of his soil.
Nothing for idle time due to the seasonal character of his vocation.
Nothing in the nature of "overtime" allowances for long working days during the busy season.

With the information at hand we cannot evaluate these three charges against the crop. But as wheat growing is carried on in Kansas, they are material factors in the cost of production.

ELEMENTS OF COST.

In order to show the elements entering into the computation necessary in determining the cost of production of wheat in Kansas, the accompanying statement showing the various charges per acre in the central division is immediately followed by statements showing the items of charge in each section of the central division These latter have been correlated in order to produce the former

	CENTRAL DIVISION	*Charge per acre*
1	Land and buildings used for wheat $81 00 per acre @ 7% (interest, taxes, upkeep) 12 30 per acre @ 13% (interest, taxes, depreciation repairs)	$7 27
2	Use of machinery (interest taxes, depreciation repairs)	1 63
3	Seed 4 40 pecks @ $2 23 per bu	2 46
4	Seed bed preparation 4 40 man hours @ 25¢ 19 20 horse hours @ 8¾¢	2 78
5	Harvesting (binding and heading) 3 60 man hours @ 7 3¢ 5 20 horse hours @ 8¾¢ Twine and oil 32¢	3 41
6	Threshing 12 00 bu @ 30½¢ per bu	3 66
7	Hauling to market 5 20 miles @ 1 1¢ per bu per mile	68
8	Insurance (all classes)	63
9	Fertilizer	79
10	Interest on seed and seed bed	.40
11	Crop risk	1 31
12	Correction for rent	14
13	Management	1 43
	Gross cost	$26 59
14	Credit by straw and pasture	1 55
	Net cost	$25 04
15	Net cost adjusted to allow for differences in acreage in different sections	$24 60

	CENTRAL DIVISION NORTHERN SECTION (C)	*Charge per acre*
1	Land and buildings used for wheat $78 40 per acre @ 7% (interest, taxes, upkeep) 13 50 per acre @ 13% (interest, taxes, depreciation repairs)	$7 24
2	Use of machinery (interest taxes, depreciation repairs)	1 72
3	Seed 4 60 pecks @ $2 24 per bu	2 58
4	Seed bed preparation 4 [illegible]0 man hours @ 25¢ 19 30 horse hours @ 8½¢	2 80
5	Harvesting (binding and heading) 3 95 man hours @ 75¢ 5 50 horse hours @ 8½¢ Twine and oil, 41¢	3 84
6	Threshing 13 00 bu @ 30¢ per bu	3 90
7	Hauling to market 5 50 miles @ 1 1¢ per bu per mile	77
8	Insurance (all classes)	.67
9	Fertilizer	98
10	Interest on seed and seed bed	42
11	Crop risk	1 56
12	Correction for rent	42
13	Management	1 61
	Gross cost	$28 51
14	Credit by straw and pasture	1.56
	Net cost	$26 95

CENTRAL DIVISION

SOUTHERN SECTION (D.)

		Charge per acre.
1	Land and buildings used for wheat. $82.89 per acre @ 7% (interest, taxes, upkeep) 11.61 per acre @ 13% (interest, taxes, depreciation, repairs).	$7 31
2.	Use of machinery (interest, taxes, depreciation, repairs).	1 54
3.	Seed 4.20 pecks @ $2 23 per bu	2 34
4.	Seed-bed preparation 4 20 man hours @ 25¢ 19.00 horse hours @ 9¢.	2.75
5.	Harvesting (binding and heading) 3.31 man hours @ 70¢. 4.88 horse hours @ 9¢. Twine and oil, 28¢.	2 98
6.	Threshing 11 00 bu @ 31¢ per bu	3 41
7.	Hauling to market 5.00 miles @ 1 1¢ per bu. per mile	60
8	Insurance (all classes)	59
9.	Fertilizer	60
10.	Interest on seed and seed bed	39
11.	Crop risk	1 05
12.	Correction for rent	—.16
13.	Management	1 25
	Gross cost	$24 65
14.	Credit by straw and pasture	1 53
	Net cost	$23 12

The object in determining the cost of production per acre rather than per bushel is found in the fact that the variations in the cost per bushel are more directly affected by the yield, and the tables here given as showing the cost of production of the wheat crop in 1919 can be used for any other year by merely changing the items which go to make up the final cost to correspond with the facts at that time.

FACTORS OF COST.

In the use of machinery, horses and labor, only that portion of the value of labor which was devoted directly to the wheat crop is included in this report. In these values 51 per cent were given by those who own and operate their land and 49 per cent by those who operate rented land. A rate of 7 per cent was allowed for the use of land, and this includes 5 per cent for the use of the money invested, 1¼ per cent for taxes, ¾ per cent for upkeep charges, such as fences, road work, etc.

The rate of 13 per cent allowed for the use of buildings or parts of buildings which were used in handling the wheat crop includes 5 per cent for the use of the money invested, 4 per cent for depreciation, 2 per cent for repairs and maintenance, 1¼ per cent for taxes and ¼ per cent for insurance. The eastern division, as shown by the map, had 25.18 per cent of its cultivated area devoted to wheat, 69.2 per cent to other crops and pasture, and 4 per cent to waste or unused land. For the central division the figures are 43.8 per cent for wheat, 54.2 per cent for other crops, and 2 per cent for waste land; while for the western part 32 per cent was devoted to wheat, 67 per cent to other crops, and 1 per cent to waste land.

In the charges covering the use of machinery, implements, wagons and harness, only such value was given as was directly chargeable in the production of wheat. This included interest on the money invested, taxes, depreciation

and maintenance and repairs, and was based on the value of the machinery and the length of useful life as reported by the correspondents.

The charge for seed includes the average cost of seed in each section, together with any expense incurred in transportation of the seed or its treatment for smut. In the labor of preparation of the seed bed and seeding the farmer was allowed a nominal charge of 25 cents per hour, which is equivalent to a hired man's wage of $55 per month and $20 per month for board. The charge for horse hours were based on interest on investment, depreciation, immediate care, shoeing, veterinary fees, and the report by each correspondent of the total number of days of horse labor used each year in the production of wheat, together with the cost per year of keeping a work horse.

Harvesting charges include the daily cost wage reported by the correspondent plus $1 a day for board and lodging. The figures reported under the head of harvest differ in different sections of the state, for the reason that harvesting is done in the eastern division almost exclusively by means of the binder, while in the western division the header is almost exclusively used, and in the central division both of these implements are used. The charge for threshing and for hauling to market were compiled directly from the replies given, though the hauling charge is based on the cost of hauling one bushel for one mile, the yield per acre and the distance hauled.

The charge for insurance covers whatever insurance was carried, though there are many farmers who do not carry insurance either on the growing crop or on stored grain. Also the charge for fertilizers is small, for the reason that many farmers do not make a practice of fertilizing for the wheat crop. It will be noted from these figures that the farmer has been allowed only the wages usually paid to a farm hand. No special pay has been credited to his account for his extra ability as a manager.

Owing to the fact that the cooperating farmers who furnished the information upon which these calculations were based may not represent the true proportion of landowners and renters which exists in the state as a whole, it was necessary to make a correction for rent. In Kansas the almost universal terms of rent are one-third of the crop, and by using the information furnished in the last government census report as the basis of calculation, such corrections were made as were necessary in each section This may appear as an addition to the cost of production on owner-operated land because of the fact that the rent exceeds the charge for the use of the land and buildings which we have used in these calculations. This correction has in every case been a slight one, but was necessary in the interest of accuracy.

It may be further stated that the results shown herewith are under rather than above the actual facts in some instances. The farmer has been allowed no extra compensation for his ability as a manager, and this should have been done; the only allowance given him in the shape of wages being that equivalent to what he actually paid the hired help on his farm.

Another element of importance in such a computation is one which is frequently overlooked, and for lack of a better term has been named "crop risk." This term is intended to provide for compensation for the seeding and preparation of wheat land from which no grain is harvested. The variable seasons in a state so large as Kansas and having such a wide diversity of climatic and soil conditions result in the failure of the farmers in some parts

of the state to harvest all of the land which has been sown to wheat, and this recurring loss must be provided against in any calculation which is intended to accurately show the cost of production. For example. If one acre in five sown to wheat is lost through climatic and other conditions, the four acres remaining must bear the cost of the seed, the seed-bed preparation and the sowing of the five acres, and this difference is taken account of under the term "crop risk." It is shown from the figures published by the Kansas State Board of Agriculture that the loss on the several divisions into which the state has been divided for the purpose of this investigation are as follows Northwestern, 11 per cent; southeastern, 9 per cent; north central, 25 per cent; south central, 18 per cent; northwestern, 38 per cent, and southwestern, 45 per cent.

It is found that the average number of days devoted to wheat in the eastern division of the state was 80; in the central division, 106; and in the western division, 104, while the average wheat fields in eastern Kansas measure 65 acres, in central Kansas, 182 acres, and in western Kansas, 235 acres.

The purpose of this paper has been to give somewhat in detail the facts which are absolutely necessary in the determination of any reliable statistics concerning a farm crop, but incidentally the inquiry has been of great benefit in other ways as well Many farmers have had their interest aroused and neighborhood discussions have been encouraged, a spirit of cooperation fostered, and the possibility of a knowledge of the cost of production in helping farmers toward a more economic method has been developed The highest value of this work in the mind of the writer lies in the fact that it will serve to remove much misinformation which exists in the minds of the public in regard to the profits which are popularly credited to the farmer, and show that the wheat farmers of Kansas, at least, are not profiteers.

Another vitally important fact that has been developed by this investigation is to be found in the example which it has set for the obtaining in an accurate and reliable manner the essential facts of cost of production upon which all business enterprises should be based and which heretofore have been so universally lacking when applied to agriculture, which is our greatest and most fundamental business.

Standards of Purity for Medicinal Agents.

L E SAYRE

The tenth revision of the United States Pharmacopœia will soon be started. The convention which will appoint the members of the next revision committee meets in Washington on May 11. About fifty revisers will be chosen at that time. It is therefore quite important at this time to call the attention of chemists to the standards that are embraced within the pages of the present revision of the Pharmacopœia. Almost every chemist who has anything to do with laboratory work or investigation and research is interested in this question of standards, and therefore it is advisable that everyone who has anything to do with chemistry shall feel free to contribute to the standards for medicinal chemicals.

It is well known that the United States Pharmacopœia does not require absolute purity with regard to chemicals. Absolute purity in many of the com-

mercial chemicals is unattainable, unnecessary or practically undesirable on account of greatly increased expense. The analytical chemist must, of course, use chemicals for volumetric solutions and reagents of the highest possible purity, but such standards are not required in medicine or pharmacy, provided poisonous or dangerous substances are rigidly excluded. Minute quantities of innocuous products will not perceptibly affect the dosage or medicinal activity of a remedy. What is known as the "purity rubric" in the Pharmacopœia represents requirements that can be easily demanded and that represent a purity which is quite sufficient for medicinal activity; as, for example, in the case of potassium bromide the purity rubric states that this salt shall contain, when dried to constant weight at 100° C., not less than 98.5 per cent of KBr, and the tests applied to eliminate possible objectionable impurities are directed against the iodide, bromate and sulphate. A minute quantity of chloride would be unobjectionable. The general tests applied are melting points, boiling points and congealing points, and these are of special value.

As to vegetable drugs the standards provided by the Pharmacopœia apply not only to the crude drug, but also to the powdered or ground drug. In the case of the powdered vegetable drug it is needless to say that microscopical standards are used, and these standards are employed by the United States government as well as by the drug laboratories Any one who will examine the Pharmacopœia and notice the descriptions of the powders will note that the microscopical analysis is quite accurately stated, so that the drug itself is well identified and every precaution is taken against possible adulteration.

The object of this paper is largely to call attention to the subject of the standardization and to interest all of those who are working in either lines of chemistry or in microscopy which has to deal with condiments or any other vegetable substances of commercial value, in order that they may take an interest in this subject and feel free to make any contributions in the direction indicated, assuring any who may do so that their work would be greatly appreciated

It may be of interest to note in this connection that among the biological products that have been introduced into the Pharmacopœia and standardized are the serums and glandular products. We have recognized, for example, the antidiphtheric serum in three forms; one in the dried form and the other two liquid—one having a potency not less than 250 antitoxic units per mil, and the other physiological salt solution which has the same number of units per mil. There is also, in the official antitetanic serum, the plain and the purified and the dried. There is also, in the glandular product, the desiccated thyroid gland and suprarenal gland. There is also the smallpox vaccine.

Indications from correspondence with biological laboratories show that since the last revision official governmental standards have been adopted for antimeningitis, antipneumococcus, antidysentery and antitvphoid vaccine. Of course, if the convention reaffirms the principles of the last convention all of these will be admitted to the Pharmacopœia without question.

As before stated, this paper is contributed largely to give information as to what is now in evidence so far as medicinal standards are concerned and what the new revision committee of the Pharmacopœia will be obliged to face.

Botanical Notes, 1919-1920.

FRANK U. G. AGRELIUS

UNUSUAL SEASONAL ACTIVITIES OF CERTAIN PLANTS, 1919-1920.

Continuing our custom begun in the latter part of 1915, we give a list of plants showing more or less unusual seasonal activities. These have all been observed by the author, and all in or near Emporia, Kan., unless otherwise specified. The plants are arranged, as far as well may be, according to Gray's Manual, seventh edition. The list follows:

Allium mutabile Michx. August 31, 1919, blooming in abundance on the North Fork of the Verdigris, in Lyon county

Polygonum aviculare Linn. November 8, 1919, blooming (?)

Delphinium consolida Linn' (?). Cultivated larkspur. October 12, 14, 16, 23, November 8, 1919.

Lepidium virginicum L. (?). September 25, 1919, in bloom

Trifolium repens L. October 31, 1919. Blooming.

Melilotus officinalis (L) Lam. September 18, 30, 1919. Blooming

Tropæolum majus Linn August 19, 1919, blooming second time this season October 4, 8, 1919, blooming pretty well.

Acer saccharinum L. February 23, 1920, staminate flowers blooming, Normal campus

Vitis labrusca Linn. Concord grape August 19, 1919, blooming These formed small green grapes later; did not mature.

Viola cucullata Ait October 4, 1919, blooming October 12, 1919, one not fully open

Œnothera speciosa Nutt September 22, 1919, blooming

Viburnum opulus sterilis L July 26, 1919, our own plant has one ball of bloom on it

Diervilla florida Sieb & Zucc Weigela rosea Blooming September 5, 27, October 4, 8, 12, 14, 16, 1919.

Erigeron ramosus (Walt.) B S P Blooming October 8, 1919 Blooming quite well October 12. Abundant on October 17 (Heavy frost October 17, 1919) October 23, 1919, doing well (blooming).

Taraxacum officinale Weber December 18, 1919, out soon as ice was melted off. December 25, blooming December 29, 1919, apparently forming a good seed ball Special note: The winter season of 1919-'20 appears to have been a very unseasonable one for this plant. The lack of snow as a covering during January and February, with the alternate freezing and thawing, was detrimental even to this exceptionally hardy plant. They resumed good growth by the last week in March

The exceptionally early appearance of winter prevented the renewal of blooming to be expected if the autumn had been warm, following the protracted and severe drouth of the summer of 1919.

FURTHER NOTES ON POLYCOTYLEDONY IN CERTAIN PLANTS

At two previous sessions of the Academy, viz., in 1918 and 1919, we have given some notes along the line of unusual polycotyledony in certain plants. We have been continuing our experiments with the castor bean, *Ricinus communis* (?), and the tomato, *Lycopersicum esculentum* Mill, and have some additional data, but rather little progress to note. We discovered two specimens of tomato with three cotyledons. We planted these among the other tomatoes with no attempt at isolation. From these we picked and saved two fruits. From these, in turn, we expect to secure more plants and to plant them in a more secluded place this year. We have also noted two more specimens of tomato in this spring's seedlings having three cotyledons each. We have these marked for testing. In the spring of 1919 we planted several castor-bean seeds, as planned, from a plant noted the previous year. It was

tricotyledonous. Among these we found a specimen with three cotyledons and have again saved the seed from it, and we are expecting to plant quite a few seeds this spring. We planted none last year but those from the chosen plant of 1918, but made no attempt to prevent cross-pollination.

The tricotyledonous castor bean of 1919 was certainly abnormal, as it had such evident seed leaves of the unusual number. Two of these cotyledons were abnormal in having an extra large size. In addition we noted that these seeds were abnormally thick in their smaller diameter. They seemed to give external evidence of their abnormal nature. However, only one of the seeds planted—a dozen or more—showed more than two cotyledons.

A Preliminary List of Insects of the Sorghum Field.

WM P HAYES *

Large numbers of insects are found in association with sorghum plants in the fields of the Great Plains area. Some feed on the plant, some are predatory, and others are casual visitants seeking shade from the sweltering sun or protection from unfavorable conditions, such as damp or dry soils.

Under a new project, "Insects Injurious to Sorghums," recently established by this department, a thorough study of the insects of the sorghum field was begun during the summer of 1919. A necessary requirement for such a work was the preparation of a list of the more common species found in the sorghum fields. In view of the recent introduction into America of the European corn borer, *Pyrausta nubilalis* Hubner, in broom corn from Europe, a survey of the Western states where this broom corn was ultimately distributed is being planned by the United States Bureau of Entomology. As this list, together with the more important references to the subject, may be of some value to those engaged in the survey, it seems advisable to present it at this time, even though it is not complete.

The writer wishes to acknowledge his indebtedness to Mr. Warren Knaus, who determined the Coleoptera mentioned in this list, and to S. A. Rohwer and A. B. Gahan, who determined most of the Hymenoptera, and also to express regret that the numerous species of Diptera, now in the hands of a specialist, are not ready for presentation at this time.

ORTHOPTERA.

Hesperotettix speciosus Scudd. (Injures sorghum in southern Kansas, Forbes, 1905, p. 142)
Melanoplus bivittatus Say.
Melanoplus differentialis Uhler.
Melanoplus femur-rubrum DeGeer.
Melanoplus atlanis Riley.
Dissosteira carolina Linn.
Gryllus pennsylvanicus Burm.

* Contribution No. 57 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results of the investigations undertaken by the author in the prosecution of project No. 92 of the Kansas Agricultural Experiment Station.

ISOPTERA.

Reticulitermes lucifugus Rossi.

NEUROPTERA.

Chrysopa oculata Say.
Chrysopa rufalabris Burm

HEMIPTERA.

HETEROPTERA AND HOMOPTERA.

Chlorochroa (Pentatoma) ligata Say. (Newell, 1915, p 15.)
Euschistus variolarius P B. (Forbes, 1905, p. 196.)
Thyanta perditor Fabr. (Sanderson, 1904, p 94)
Thyanta custator Fabr (Morrill, 1910, p 8.)
Apateticus (Podisus) maculiventris Say.
Leptoglossus phyllopus Linn (Forbes, 1905, p 203)
Aufeius impressicollis Stal
Nysius ericæ Schill
Blissus leucopterus Say
Sinea diadema Fabr
Pagasa fusca Stein
Nabis (Coriscus) ferus Linn
Triphleps insidiosus Say.
Monecphora bicincta Say. (Hutson, 1918, pp 186, 187)
Stictocephala festina Say. (Wildermuth, 1915, p 346)
Stictocephala rufivitta Walk. (Wildermuth, 1915, p 346)
Dræculacephala mollipes Say (Forbes, 1905, p 205)
Homalodisca triquetra Fabr (Sanderson, 1906, pp 50 and 53)
Oliarus aridus Ball.
Ormenis pruinosa Say (Forbes, 1905, p. 203)

APHIDIDÆ

Wilson and Vickery (1918, pp. 336, 337), in their list of food plants and aphids said to attack them, cite the following aphids as associates of sorghum plants.

"On *Sorghum* sp.
Aphis sorghella Schoutenden.
On *Sorghum dora.*
Aphis maidi-radicis Forbes.
Aphis maidis Fitch.
Sipha flavus Forbes.
On *Sorghum halepense.*
Aphis avenæ Fabricius.
Aphis maidis Fitch.
Aphis maidi-radicis Forbes.
Sipha flavus Forbes.
Sipha maydis Passerini.
Tetraneura ulmi Linnæus.
Toxoptera graminum Rondani.

On *Sorghum saccharatum—S. vulgare.*

Aphis avenæ Fabricius.
Aphis maidi-radicis Forbes.
Aphis maidis Fitch.
Macrosiphum caianense Del Guercio.
Pemphigus fuscifrons saccharata Del Guercio
Pemphigus radicum Boyer.
Sipha flavus Forbes.
Sipha maydis Passerini.
Tetraneura ulmi Linnæus.

On *Sorghum vulgare.*

Anæcia corni Fabricius.
Aphis africana Theobald.
Aphis avenæ Fabricius.
Aphis sorghi Theobald.
Pemphigus radicum Boyer
Tetraneura ulmi Linnæus.
Toxoptera graminum Rondani."

Pemphigus (Tychea) brevicornis Hart (Chittenden, 1903, p. 62.)

COCCIDÆ

Pseudococcus sacchari. (Anon, 1912, pp. 466-469.)
Pseudococcus calceolariæ Mask. (Halloway, 1913, p 4.)

COLEOPTERA.

Cicindela trunquebarica Hbst
Cicindela punctulata Fabr.
Calasoma calidum Fabr
Bembidium constrictum Lec
Pterostichus substriatus Lec
Pterostichus stygicus Say
Pterostichus permundus Say.
Pterostichus lucublandus Say. (Knight, 1916, p. 763.)
Cratacanthus dubius Beauv.
Harpalus caliginosus Fabr. (Knight, 1916, p. 763.)
Harpalus pennsylvanicus Dej.
Harpalus testaceus Lec.
Cryptobium pallipes Grav.
Tachyporus sp.
Phalacrus politus Mels.
Eustilbus (Olibrus) apicalis Mels.
Eustilbus nitidus Mels.
Acylomus calcaratus Casey.
Hippodamia convergens Guer.
Megilla fuscilabris Mels.
Scymnus collaris Mels.
Horistonotus uhleri Horn. (Gibson, 1916, p. 3.)
Cryptorhypnus pectoralis Say.
Limonius californicus Mannh. (Graf, 1914, p. 16.)

Collops 4 = maculatus Fabr.
Atænius gracilis Mels.
Lachnosterna cribrosa Lec. (Vickery and Wilson, 1919, p. 243.)
Anomala semilivida Lec. (Titus, 1905, p. 88.)
Dyscinetus (Chalepus) trachypygus Burm. (Chittn., 1905, p. 604.)
Euetheola (Ligyrus) rugiceps Lec. (Forbes, 1905, p. 99.)
Myochrous denticollis Say. (Forbes, 1905, p. 103, and Titus, 1905, p. 88.)
Diabrotica 12 = punctata Oliv.
Diabrotica balteata Lec. (Marsh, 1910, p. 77.)
Diabrotica vittata Fabr.
Diabrotica longicornis Say. (Webster, 1913, p. 2.)
Haltica torquata Lec.
Chætocnema denticulata Ill.
Chætocnema pulicaria Cr. (Forbes, 1905, p. 10.)
Chætocnema confinis Cr.
Chætocnema ectypa Horn. (Anon., 1909, p. 568.)
Eleodes tricostata Say. (Parks, 1918, p. 388.)
Eleodes opaca Say (McColloch, 1919, p. 185.)
Anthicus difficilis Lec.
Anthicus confusus Lec
Sphenophorus maidis Chittn (Hayes, 1916, p. 122.)
Sphenophorus phœniciensis Chittn. (Morrill, 1915, p. 39.)

DIPTERA

Gonimima unifasciata Desv. (Knight, 1916, p. 760.)
Contarinia sorghicola Coq
Winthemia quadripustulata Fabr. (Knight, 1916, p. 760.)
Musca domestica Linn.
Chætopsis ænea Wied. (Forbes, 1905, p. 164.)

LEPIDOPTERA.

Celama (Nigetia) sorghiella Riley. (Anon., 1909, p. 570, and Forbes, 1905, p. 169.)
Heliothis obsoleta Fabr.
Lycophotia margaritosa Haw. *saucia* Hübner.
Cirphis (Heliophila) multilinea Walk. (Vickery, 1915, p. 389.)
Cirphis (Heliophila) latiuscula H. S. *subpunctata* Haw. (Vickery, 1915, p. 389.)
Cirphis (Heliophila) unipuncta Haw. (Vickery, 1915, p. 389.)
Neleucania (Leucania) albilinea Hübner. (Forbes, 1905, p. 83.)
Laphygma frugiperda A. and S. (Chittn., 1905, p. 601.)
Pyrausta nubilalis Hübner.
Diatræa saccharalis Fabr. (Forbes, 1905, p. 92.)
Diatræa zeacollella Dyar. (Ainslie, 1919, p. 4.)
Elasmopalpus lignosellus Zell. (Anon, 1906, p. 634.)
Pyroderces (Batrachedra) rileyi Wals. (Anon., 1907, p. 510.)
Sitotroga cerealella Oliv. (Newell, 1915, p. 11.)

HYMENOPTERA.

Meteorus communis Cress. (Knight, 1916, p. 761.)
Apanteles militaris Walsh. (Knight, 1916, p. 761.)
Apanteles rufocoxalis. (Knight, 1916, p. 761.)
Ichneumon lætus Brull. (Knight, 1916, p. 761.)
Tetrastichus sp. (Dean, 1911, p. 55.)
Bembex sp.
Aprostocetus diplosidis Crawf. (Dean, 1911, p. 55.)
Apis mellifica Linn.
Ageniella n. sp. (det. by Gahan.)
Halictus sp.
Ageniella sp.
Ceropales foxii Roh
Dasymutilla sp.
Diodontus suffusus Fox.
Nysson sp.
Silaon sp.
Perilampus sp
Eurytoma sp.
Spilochalcis sp.
Anteris nigriceps Ashm
Apanteles sp.
Microbracon sanninoideæ Gah.
Apanteles sp.
Hoplogryon n. sp. (Det. by Gahan.)
Pheidole sp.
Ponera sp.
Cremastogaster sp.
Iridomyrmex humilis Mayr. (Anon., 1908, p. 542.)
Pogonomyrmex barbatus Smith. (Forbes, 1905, p. 159.)
Pogonomyrmex occidentalis Cress.
Solenopsis molesta Say.
Monomorium minutum Buck.

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How to Determine Altitudes Satisfactorily With an Aneroid Barometer.

J E TODD.

The purpose of this paper is to give a few simple rules by the observance of which the local influence of the weather and other temporary conditions may be eliminated and the normal pressure of the atmosphere at that point be definitely determined. The difference in the normal or average atmospheric pressure at two points will give their difference in altitude.

There are three fields in which the aneroid is an almost ideal instrument:

1. The determination of the height of mountains and other points in a mountainous region. These are miles apart and vary thousands of feet in height. An admirable plan for the use of the aneroid in such a field was devised by Gilbert years ago and was published in the second annual report of the United States Geological Survey, page 403 *et seq.*

2. The ascertaining of altitudes in regions of low relief, hilly and plains areas. The differences in altitudes between adjacent points are from a few

feet to a few hundred only. The determination of gentle dips or of low anticlines and other "structures" employ similar means and methods. Such cases may therefore be grouped in this class.

3. The third use of the aneroid is to give the altitude of aeroplanes. This, so far as the writer is aware, has not been critically studied, and besides has very little to do with geology.

Our discussion will be particularly of the second field, in which the writer has had more than forty years' experience, mostly on the great central and western plains.

Believing that this handy instrument has been misinterpreted and underrated by many, this paper attempts to correct these errors.

CAUSES OF BAROMETRIC VARIATIONS.

These may be grouped, for convenience, under three heads, viz.: First, influences of the weather; second, peculiarities of the instrument; and third, peculiarities or errors of the observer. Weather influences are real and much the most important. The others must not be ignored, though effects are more apparent than real.

WEATHER INFLUENCES.

1. *Expansion of air by heating.* This heat comes from the sun, and practically all of it is imparted to the atmosphere at the surface of the earth. When the sun shines after darkness or after a cloud has passed, it heats the earth, which by contact and convection heats the layers of air just above. This tends to expand it, but the superincumbent ocean of air resting upon it prevents. In time, however, the heating is sufficient to overcome the weight, inertia and friction of the upper air. We may suppose the surface of the atmospheric ocean is locally raised in a broad hummock. This will rise till gravitation causes currents of air to lower areas of the atmospheric ocean. This will reduce downward pressure over the heated area.

Meanwhile the barometer will rise until the superincumbent air begins to give way, when it will fall while the disturbing factor acts. It follows that days when clouds float across the sky have a very unsteady barometer. It is hardly worth while to use the barometer unless it is your only chance.

2. *Aqueous vapor.* This is lighter than air and readily mixes with it. The capacity of the air to absorb it increases with the temperature, but much more rapidly and irregularly. Its general effect is to simply magnify the effect of the preceding.

3. *Wind.* For convenience, we consider this as a separate cause, though really it is a particular effect of cause one.

The pressure of the air will remain about the same when the air is unheated and still, but in case it is moving rapidly horizontally it will tend to increase the density of the air on the windward side of objects, either a cliff, a house, or even the body of a person, and to decrease the density and pressure on the lee side. The harder the wind is blowing the greater is this effect. Not infrequently the barometer may read the difference of two or three hundredths of an inch on opposite sides of the body at the same level. Another anomaly is that when the wind strikes against a precipitous cliff or the wall of a building it is diverted upward with such velocity as to lift it above the flat roof of a building or the brow of the precipitous cliff. These also

may be so strong as to produce a difference of pressure of two or three hundredths of an inch upon the same level. The greatest pressure will be in the wind on the brow of the cliff; while a few rods further back the air will be still and the pressure diminished according to the force of the wind.

Southerly winds are attended with falling barometer, because the superincumbent air becomes warmed and lighter. Northerly winds give opposite results.

Both "diurnal variation" and "annual variation" are not causes of variation, but curves of barometric pressure for a day or a year. They are the results of causes 1 and 2 affected by local geographic conditions

Diurnal variation is a more or less regular rising and falling of the barometer during the twenty-four hours of a day. The barometer begins to rise as soon as the day breaks and continues to 10 o'clock a. m.; then it falls slowly until about 3 p. m.; then rising again to other culminations at 10 p. m., then falling again to about 2 a. m. These culminations may vary from 9 to 11 or from 2 to 4. The earlier time comes when the sun appears early, as in the summer time. This more or less regular rising and falling of the barometer is really due to the causes already enumerated, but it is well to remember the general form of the diurnal curve, as it is called. The diurnal curve will have wider range in the summertime than in the winter, and on sunshiny days rather than cloudy. A knowledge of this diurnal curve should be constantly kept in mind when reading the barometer or working up one's notices.

Annual variation. There is also a prominent curve for the year which is called annual variation. This is more pronounced where the difference in the seasons is greater In tropical regions it is less pronounced and more regular.

These causes of variation are constantly active, and we need to make allowance for them in order to eliminate them from difference in pressure simply due to altitude

INSTRUMENTAL ERRORS

Delicate and sensitive instruments are usually kept stationary and under as uniform conditions as possible This is impracticable in the use of the aneroid. Hence we will briefly mention a few sources of error under this head.

1. *Unequal heating of different parts* This distorts the instrument and vitiates results incalculably. Larger instruments are especially subject to this trouble; hence they are rarely if ever used in the field. The most reliable size for general field use has a face of a diameter not less than 2½ inches and not more than 3½ inches.

2. *Misadjustment of the index.* If the index is correctly adjusted to its scale in altitudes from sea level up to 3,000 feet, one-hundredth of an inch would correspond to 9 feet on vertical scale, when the temperature is about 60° F. If it should be 10° below zero there should be a difference of 8 feet in altitude, or corresponding to one-hundredth of an inch; and temperature 120° above zero, 10 feet for one-hundredth of an inch It is well because of this variation to test the instrument from time to time or compare the instrument with a known difference in altitude. This may be obtained by the comparison of the instrument at two stations whose altitudes are known, or in a building several stories high where careful measurements can be made.

3. *Friction at joints,* which requires a gentle tap to loosen the parts so they will respond freely to the hairspring.

4. *Tardy response of the instrument* to considerable and sudden differences of pressure, which may be due to slow resilience of the cylinder or main spring.

PERSONAL ERRORS.

These are similar to other cases which require close scrutiny and careful discrimination. As a rule, a more monotonous scale, like one marked in tenths and hundredths of an inch, is less easily read to hundredths than one marked in tenths and twentieths.

RULES FOR READING THE ANEROID FOR ASCERTAINING RELATIVE ALTITUDES.

1. Hold the instrument with its face horizontal and the eye of the reader over the center of the instrument.

2 If the wind is blowing, hold the instrument on the side half way between the windward and leeward points; or if the reading is taken on the windward side, it should be taken on the leeward side also, and each taken at its maximum.

3. Tap gently in order to overcome any stiffness of joints or weakness of hairspring

4. If index is coarse, read on one side, preferably on the left side.

5 The hand should not touch the metal portion of the instrument when the reading is taken

6. In reading it is customary to use a magnifying glass, and this distorts the image of the index. The index should always appear as a straight line when the reading is taken As long as it appears curved it is not at the true reading.

7. In some instruments the index is so broad that it cannot be read very closely unless you take one side and make that the reading point. Of course the reading should always be upon the same side of the needle or index.

8. The instrument should always have the same vertical relation to the level recorded It is well to form the habit of standing with the feet upon the level

9 Care should be taken to prevent jolt or collision of the instrument with surrounding objects. It is well to have the instrument so fastened in the case that if dropped the metal portion should be kept from striking any solid object

10. As to what to record, the following method has been found the most satisfactory: If your instrument has a scale of feet, have little or nothing to do with it. It is a trouble and apt to be a snare. Make constant use of your watch. Keep a record of the time of reading. A wrist watch is very helpful.

Check the record of readings as often as possible, at least two or three times a day. This may be done by reading a second time at any one station. The day's trip should be planned in such a way as to cross one's course several times. Of course the difference in reading at any one point will indicate the variation, due to weather conditions, of the instrument during that time, and this makes it necessary to read the time for every reading of the barometer. This will enable one to distribute the variations in the pressure of the air according to the time that has elapsed. We have considered many differ-

ent causes of variation, but really it is not important to know how much each of these may be in any particular case. We may assume that where the variation has two or three hundredths of an inch it has been in a nearly uniform direction, though it may have been a combination of several of these causes. Checking of the record may also be obtained by reading bench marks provided beforehand either at some point fixed by the survey or determined by railroads. Another easy means of checking, if near a large stream, is by taking readings at the surface of the water. A large stream is virtually horizontal; the slope of the Missouri river, for example, is less than a foot a mile. Of course a lake would be exactly horizontal.

CONCLUSIONS

1. If these rules are carefully followed you may count on determining the difference in altitude between two points to be within 10 feet of correct; even to 5 feet if conditions are favorable.
2. By this means one can determine a slope of from 5 to 10 feet per mile.
3. The accuracy may be increased by the use of an automobile, which enables one to make readings at different points in very short time.
4. The aneroid is of special service, if not indispensable, in rough and timbered areas where few stations are in sight of one another.
5. It is particularly helpful in working out disturbed strata rapidly, and therefore most convenient for rapid reconnoisance of oil structures.

Archæological Notes on Pine River Valley, Colorado, and the Kayenta-Tuba Region, Arizona.

ALBERT B REAGAN.

The work on these areas covers the period from 1916 to 1920, as time would permit. For convenience, each region—Pine river, Kayenta, and Tuba—and the notes on same will be considered separately.

THE ANCIENT RUINS IN LOWER AND MIDDLE PINE RIVER VALLEY, COLORADO.

Pine river, a tributary of the San Juan, runs nearly north and south from about the south line of Colorado northward to the top of the San Juan range, at about a third the distance from Durango to Pagosa Springs. The stream is of rapid current and carries a large volume of water, enough to irrigate a much larger area than is now irrigated by it. The lower and middle inner valley, which is elevated but little above the stream, is usually not over half a mile wide. The first bench encircling this varies in width from a quarter to a half mile, and in elevation from twenty to forty feet. Surrounding this bench is the mesa country, which rises some sixty feet above the first bench and extends back on each side of the river to the mesa-mountains as a table-land country, the width varying greatly. The inner valley and first bench are composed of silt and cobbles. The mesa is adobe overlying cobblestones of the Durango glacial stage and occasional country rock, with knobs of country rock jotting above the plain here and there. Originally, large sagebrush covered the whole region, among which were scattered cedars and piñons.

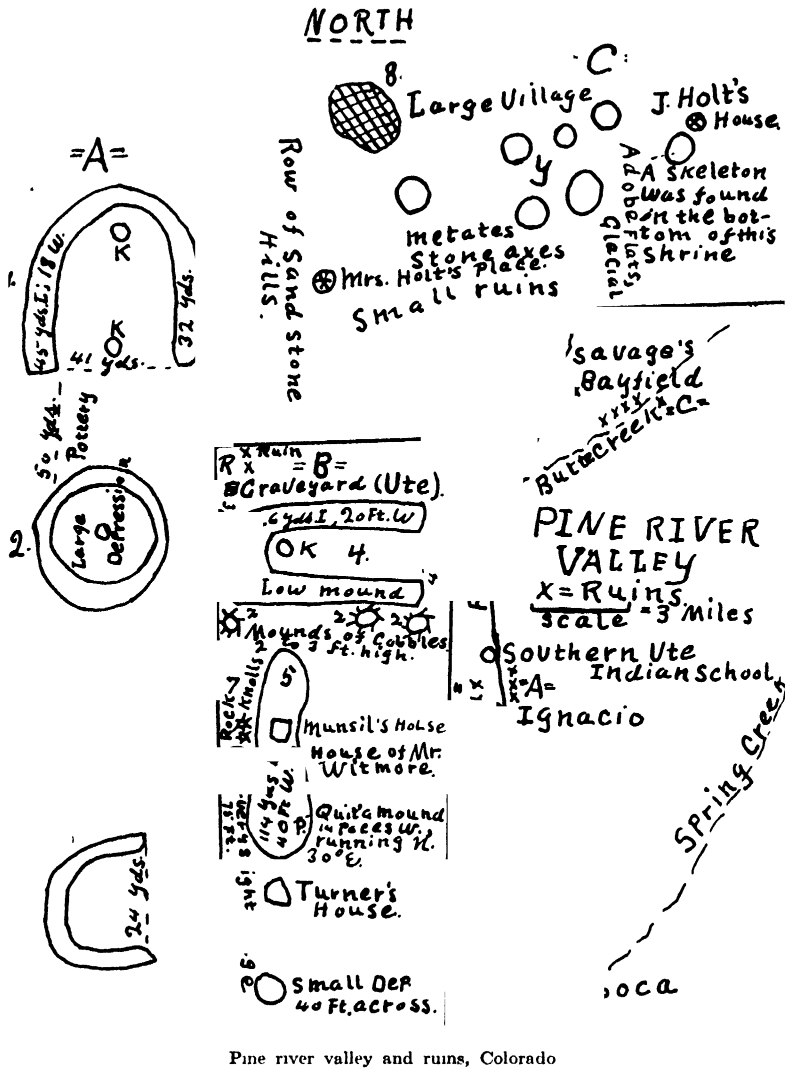
To-day fine irrigated farms cover considerable of the area, and along the stream are the thriving towns of Bayfield, La Boca and Ignacio. The region for many years has been the home of the Southern Ute Indians, and the Southern Ute boarding school and agency are now situated at Ignacio. Much of the region is now settled by white people. The principal crops raised are alfalfa, wheat, oats, barley, potatoes, garden truck and fruit. One year, when the writer had charge of the Indian school there, 400 bushels of potatoes were raised on a single acre of the school land, and 19 acres of meadow produced over 100 tons of alfalfa. The elevation is about 6,500 feet. The climate is mild. There is snow in winter, and in summer 90 degrees of heat is seldom reached. From mid-July to the close of September it showers nearly every afternoon. The climate is healthful.

This region has never been touched in an archæological way. In the long past this region was inhabited by a race of tillers of the soil and builders of villages, as is attested by the scattered ruins on the edge of the mesa on both sides of the river and also in the Butte creek region east of Bayfield. In many respects the ruins resemble those of the "Small-house People" of northern New Mexico, previously described in *El Palacio* (W. B. Douglas, in April and July numbers, 1917), but differ from those in that at least in several instances the buildings were made of poles, stood apparently in upright position, and adobe mortar plastered on both sides of these to make the walls. In several other instances a form seems to have been made of poles and the adobe poured into it and let dry. The ruins of Keetseel and Betatakin, in the Kayenta section, also have walls still standing in a good state of preservation, made by each of these systems. The solid adobe walls were all made by the puddling process. The roofs were made of cedar poles, over which brush and probably rushes were placed, and on top of this mud was placed. Many of the ruins were destroyed by fire, as is attested by the adobe being burned to a brick consistency.

There are many ruins in the region, but as time would not permit, only a few near the school were visited by the writer. These were the ruins near La Boka; at Bayfield; at Mr. Marion Savage's place, west of Pine river, two miles west of north of Bayfield; at Butte creek, on the mesa east of Pine river, one mile southeast of the Southern Ute boarding school; and a string of villages west and northwest of Ignacio. The ruins at La Boca and in the vicinity of Bayfield were not examined, and the rest were examined only superficially. Below is a description of the ruins examined.

Ruins on the mesa across the river, east of the Indian school (marked "A" on the plate). The ruins here lie in a north-and-south direction, just back of the west front of the mesa, east of the Southern Ute agency and school. There are three major ruins (numbered 1, 2 and 3 on the plate), and some scant remains of what appears to be detached houses. The villages seem to have been placed on the edge of the mesa, which is slightly ridged here, so as to be close to the fertile valley lands of the river adjacent, and also to be able to overlook both the valley and the mesa eastward from them, as a matter of protection from enemies. From the evidence, the ridge was inhabited throughout probably hundreds of years, and it is now hundreds of years since the simple-hearted folk left their happy homes to the wearing away of the elements. To-day not one foot of wall appears to be in place; only tumbled heaps remain, and from appearances even much of these has been leeched

TRANS. KANSAS ACAD. SCI., VOL. XXX PLATE I.



Pine river valley and ruins, Colorado

out and carried to the valleys by the dashing rains, melting snows and whirling winds of the coming and going years. Around the ruins, especially that of village number 1, there are numerous pottery fragments and pieces of chipped flint scattered here and there; and in the case of the village cited, they blanket the hillside and extend quite a distance toward the village from it. Arrowheads, stone axes and grinding slabs are also present in considerable numbers. Sagebrush, cedars and piñons overtop these ruins now.

No. 1 is the ruin of a very old village, as has been suggested. It was also occupied for a long period of time, as is attested by the great quantity of broken pottery scattered hundreds of feet on each side of it and extending

from it down the hill slope to the westward, as has been stated. The village is in horseshoe shape, with an original width of probably fifty feet. Its plaza opened to the south. Within it are two circular depressions (figure K), which were probably kivas (*estufas*). The village debris is now three feet thick. The places seem to have been sacked and destroyed by an enemy, as the room mortar was burned into brick.

No. 2 is the ruin of what appears to have been a circular village, from which no openings can now be discerned. It also evidently had a high wall, as is attested by the bulky mass of debris. A large, deep, circular depression occupies its center, and was probably a kiva. From the more scanty pottery remains, it was evidently not occupied so long as ruin No. 1, though at one time it might have been continuous with it, as the pottery shards are continuous. It was also likely a much later village, as its mound seems to be better preserved, it appears not to have suffered so much from the ravages of time.

No. 3 is a ruin some 200 feet south of No. 2 It is built in horseshoe shape, facing the east. Its widest space between house walls appears to have been more than twenty feet. The mound is now low and hardly traceable. There is much pottery scattered about the place From appearance, it is as old as village No. 1, or older. It has suffered from the ravages of time till it is almost obliterated. It is easy to conclude that many revolving centuries have passed since fate drove the industrious workers from this home or allowed them to perish in it

The ruins on the mesa west of Ignacio (marked "B" on the plate). On the east edge of the mesa immediately west of Ignacio is a series of ruins extending in a north-and-south direction for probably half a mile. They are extensive and for the most part are apparently practically continuous, with outlying villages extending to the northwestward. On account of the area being under cultivation these ruins are much disturbed, and in most cases the original position of the debris cannot now be determined. Moreover, after the Utes were moved to this region by the government they also made this ridge their village site till they were persuaded to take lands in severalty, they also making their graveyard on the ancient ruins Consequently, in the present disturbed condition it is hard to tell exactly what is Ute and what ancient debris. The ruins that can be traced, however, are of the Pueblo type, and the fragments of pottery and the buried grinding slabs evidently belonged to that race. The Ute rubbish was evidently only a veneer to the ancient debris before the same was heterogeneously mixed by the white man's tilling the soil.

The people who occupied these ruins evidently occupied them for a long period of time, as is indicated by the broken pottery and by the worn metates. The rubbing of hand pieces (manos) less in size than the grinding slabs have worn deep grooves, often six to ten inches deep, in the hardest kind of rock. The large size of these slabs also indicates that they must have been permanently placed in some sort of a frame as are the grinding slabs of our Pueblo houses at the present day. They were evidently too large to be used by a wandering people. Notwithstanding the evident antiquity of the basic ruins, the living of the "Small-house People" there is apparently later than that of the peoples who occupied the site across the river from the Indian

school, as there is a greater bulk of debris and less pottery. Moreover, as in the case of the former ruins, there is evidence that at least a part of these ruins were destroyed by fire, and likely in an attack.

As previously suggested, the main ruin begins at the Ute graveyard and extends along the mesa front for a distance of about a half mile to about forty feet north of Mr. Turner's house. South of his house there are also indications of there having been detached houses here and there in the long-distant past. Throughout the whole distance there is an almost uninterrupted continuation of village mounds, pieces of pottery, brick-burned clay slag, grinding slabs, hand pieces (manos), chipped flint fragments, arrowheads, etc. The figures covering this area are 4, 5, 6, and 7, with accompanying lettered objects.

No. 4 is the outline of a ruin in elongated horseshoe shape, just north of Mr. Munsil's house. It is open to the west and extends eastward to the very edge of the mesa. Its north limb is now low. Within it is a shallow circular depression (figure K), which was likely a kiva. Just south of it are three small cobblestone mounds (figure Z), which are likely the remains of ovens.

Just north of this ruin (No. 4) is the Ute graveyard, which shows the former Ute mode of burying the dead as was practiced by them soon after they were transferred to the region. Farther on to the northwestward are the small ruins (figures R). Each is very small in size, but seems to show the horseshoe-shape type. Each is a tumbled mass grown over with dense sagebrush, among which are scattered fragments of pottery of the Small-house village Indian type.

The pottery found here, as at the other ruins examined, was very thin, and for the most part had been pressed in shape with the hand, or likely a gourd rind, as the Jemez women make pottery to-day, though the pottery was of a much better quality than that of the Jemez of the present time. A few pieces of pottery found, however, showed that the mud had been pressed into a woven basket or woven form—in a case or two, over the form—and dried. Then the form was removed in the pot-burning process. Some also were thumb-marked or corrugated ware. The pottery varied in size from small urns, probably used in religious ceremonies, to jugs with handles or knobs for carrying, and large trays, which were probably soup containers. The ears of some of the eared pots were also perforated for the fastening of carrying straps. Most of the pottery was painted an ashen color and was further decorated in black and red designs, among which were raindrops, clouds, snakes, the swastika of the four winds, the sun, moon and stars (the latter are simple crosses), the thunder bird, and the steps to the happy hunting ground.

No. 5 is a continuous ridge of debris ranging from two to four feet in thickness, probably the remains of a succession of villages, now jumbled together in a plowed field. On the east side, facing the edge of the mesa and valley, are the distinct remains of a small horseshoe-shaped village (figure 6). It would seem that this village is more recent in time than the other villages of this ridge, as it is superimposed on the debris of former villages. Above this village are two round knolls (figure 7), which probably are the remains of ovens. In addition, in the northeast part of the main village area is a mound (figure P) fourteen paces wide, which was probably a watchtower, though this is simply conjecture. Then some distance south of Mr. Turner's house is a

small circular depression forty feet in diameter and of considerable depth. Near it also is a circle of cobblestones some ten feet in diameter (almost like shrine No. 24 of the Small-house People, described by Mr. Douglas in *El Palacio*, July, 1917, p. 21). These are probably the remains of a kiva and an open altar (shrine).

As stated, the site of these ruins has been used as farm land, and is now being laid off in town lots. Houses are being built on the old ruins and considerable excavation done. In this work many valuable curios have been unearthed. Most of these so far obtained were found in excavating a cave on Mr. J. C. Whitmore's place and in a garden south of the Whitmore house. Among these were an earthen duck about normal size, crude pottery intact, several large jars, several jugs, vases, some shallowlike dishes, almost a perfect goose, ordinary pottery, a stone pipe (cloud blower), several human skeletons, several metates and manos, several pestles, and a mystic snake bowl. The latter is of special interest. It was about six inches through and nine or ten inches high. It had serpents drawn around its bottom and bulged part. It also had a hollow bottom, so that the hollow would fit over a marble. Undoubtedly it was made to fit over a point of some kind similarly, and was made to whirl round while placed on this point. Placing the jar on a marble and whirling it round and round, the snakes were so placed on it that they appeared to be running and dodging past each other on the surface of the jar. It is too bad that this valuable collection has passed into private hands and been lost to the scientific world.

The ruins at the head of Butte creek (marked "C" on the plate). Butte creek, a tributary of Pine river, heads in the hill country east of Bayfield. Its upper middle course runs through a level basin area surrounded on all sides by hills of residual rocks. In this area there are abundant remains of a former civilization of a people of the Small-house type. The whole area is fertile and no doubt was farmed by this people in those far-off times, using the water of the stream for irrigating purposes. The ruins are numerous, but only one reaches the village size. At places here and there over the flat area are the remains of what was probably a single house of the puddled adobe type; also scattered here and there over the area are pestles, metates, manos, Indian axes, mallets, etc. Large circular depressions, often with raised borders, also occur here and there. Furthermore, instead of being perched on the edge of a mesa, as in the case of the other villages described, the main village is placed on a hill, and in addition it is composed partly of rock instead of all of adobe as the others are.

It is likely that the single lodges were summer lodges, used very much like the outlying lodges often used by the Jemez in tending and watching their crops in summer. The circular depressions, 40 to 100 feet in diameter (figure Y), seem to be too numerous and too large to have been used as kivas (without roofs) unless this flat was a ceremonial assembling place for all the inhabitants of the upper San Juan region in that distant time. The village, though large, never had people enough to necessitate that many kivas. In many respects they resemble Mr. Douglas' "depression shrine," in the article cited, pages 17, 23 and 25. It would, however, seem that they were reservoirs and were used to store water in high-water time for use in the drier part of the year. This theory is strengthened by the fact that they are in flats, where

there were undoubtedly fields in that day; none are near the main village. The village is quite large and the debris to-day is a massive pile. Two plazas and several *estufa* (kiva) depressions can be discerned. Fragmentary pottery, chipped flint, grinding slabs and other artifacts are scattered about the place Everything indicates that a numerous population, probably over 700 souls, once inhabited the site.

TUBA AND VICINITY, ARIZONA, WITH INCLUDED RUINS

INTRODUCTION.

Tuba (with the neighboring wash and village of Moenkopi) is an oasis in the western Navajo desert about half way between Flagstaff and Marsh pass, near the Utah line It owes its existence to living springs, as does the sister places of Moenkopi (Indian village and fields of Moenkopi wash two miles distant), Moa Ave, five miles to the southwest, and Reservoir canyon, a mile and a half to the eastward.

This oasis has received but little mention, though it is the headquarters of the western Navajo agency, which controls 6,000 souls who roam over an area as large as Massachusetts and Rhode Island combined Those who have written anything bearing directly on the region are Hough,[1] Lewton,[2] Coues (Elliot),[3] Joseph Little ("Hamblin"),[4] Gregory,[5] and reference relating to the whole region, as included in Mr Gregory's "Water-supply Paper on the Navajo Country," to which the reader is referred. Mr Grégory's three papers, "Geology of the Navajo Country," "Water-supply of the Navajo Country" and "The Oasis of Tuba, Ariz.,"[6] are the most important papers. Tuba is directly mentioned in both the first and second, and the third is written directly about it, as the title indicates. But in all his papers he refers to the ruins in but one paragraph, in these words "Ruins near Tuba, at Honogee, and the mass of debris over which the present Hopi village of Moenkopi is built, indicate a very ancient occupation"—a very slight mention of the ruins

For convenience and to give the reader a better understanding of the region, the following subjects will be considered in the order given Geology; soil and water supply; climate; fauna and flora; and habitation of man.

GEOLOGY, SOIL AND WATER SUPPLY.

GEOLOGY. Tuba is perched on the Kaibito plateau, overlooking Moenkopi canyon wash and the Painted Desert to the southward and the escarpment formed by the tilted rocks of Echo cliffs to the westward To the east is Reservoir canyon and to the northward the interminable sand dunes and clumps of sage extend farther than the eye can reach. The area itself is a jumble of sand dunes and jutting rocks, with a few scantily watered, fertile patches. The irrigated land at Tuba proper does not exceed 40 acres; and

[1] Hough, Walter, The Hopi in relation to their plant environment American Anthropologist, X (1897), 33, 34.

[2] Lewton; The cótton of the Hopi Indians Smithsonian Misc. Coll., LX (1912), No 6, 1-10.

[3] Translation from Coues, Elliot; On the trail of a Spanish pioneer, II, 358

[4] Little, Joseph (Jacob Hamblin); The Desert News, Salt Lake City, 1909.

[5] Gregory, H. E.; Geology of the Navajo country. Professional paper 93 of the U S. Geological Survey (1917), pp 1 to 161. Water-supply paper on the Navajo country: Water Supply Paper 380 of the U S. Geological Survey (1916), pp 1 to 219. The oasis of Tuba, Ariz.: Annals of the Association of American Geographers, vol. V, pp. 107-119; 1915

[6] Loc. cit.

the waters from Reservoir canyon and Moenkopi washes combined, including the springs in the canyon walls, are capable of irrigating about 1,000 acres of land on the floor of the latter wash. There is also a small field or two in Reservoir canyon. These small patches comprise practically all the permanently farmed area in a region containing 7,000 square miles. For this reason this region has been called the Tuba oasis.

In a geological way, the following formations are represented in addition to the dunes and valley fills: Navajo sandstone, Todilto formation, Windgate sandstone, Chinle formation, and Shinarump conglomerate.

The Navajo sandstone covers the plateau area. It is composed of light-red, massive, cliff-making, cross-bedded, fine and variegated sandstone. The formation is here worn to a thin edge, so to speak, its entire thickness exceeding 500 feet farther to the northward. Immediately beneath the Navajo sandstone is a series of thin-bedded sandstone and shale, which is water bearing The shale often contains sandy lumps and flattened calcareous mud pebbles. It is exposed only in the canyon walls, and is probably the Todilito formation Also exposed in the canyon walls beneath the shale strata are massive, light-red to bright-red, crossbedded sandstone, which appears to be of the Wingate formation. The rock of this formation makes fine building stone and was used in making the government buildings at Tuba. The three formations belong to the La Plata group of the Jurassic series.

The Chinle formation and the Shinarump conglomerate are exposed south of Tuba. The former is composed of shales with thin sandstone and limestone conglomerates, much variegated, and contains much fossil wood. It is a most beautifully colored formation, often banded when forming bluffs and canyon walls The colors striking the eye as one travels through the region are sienna, slate, various shades of brown and red, blue, white, black, chocolate, maroon, lilac, drab, purple, gray, pink, rose, ash gray, lavender and yellow Truly the region deserves the name "Painted Desert." The conglomerate (Shinarump) series is composed of a gray conglomerate and sandstone, also containing much fossil wood The Shinarump is probably 60 feet thick; the Chinle probably 400 feet The two formations belong to the Triassic series.

The McElmo and Mancos formations are also exposed in the region.

Soil The soil of the oasis and also of Moenkopi wash is of the weathered country rock, limestone and lime-cemented sandstone, and from dust particles from volcanic calcareous and agrillaceous rocks blown over the region from the Little Colorado valley by the wind. Alkali is present and is damaging fields both in the wash and in the northeast fields at Tuba. Buried organic deposits, including roots and stalks of semidesert plants, furnish the organic constituents of the soil. Fine crops are raised in the area annually.

Water Supply. The Navajo sandstone forming the cap of the Kaibito plateau is a very cross-bedded sandstone, as we have seen. It also contains soft spots, which are blown out by the wind, forming potholes if a horizontal surface, or cliff spaces and caves if along vertical faces. When it rains the potholes fill with water and remain so till the water is evaporated, or it seeps through the rock to some underground outlet. And again, the shifting sand piles whole washes full, as it is now filling up Reservoir canyon, and also pockets large areas in circling dunes, covering parts of the area north of Tuba,

which, as a whole, is larger than the state of Connecticut. This ponding of the water also causes it to seep through the rocks to a lower outlet through the massive, cross-bedded, porous Navajo sandstone. Reaching the thinner-bedded sandstone and shale, it follows it. Approaching where this shale is nearly or wholly exposed, the water issues from the joints in the sandstone and from the shale exposures. This has been brought to the surface by abrasion and weathering and by exposing the water-bearing horizon by canyon cutting. Through this process many springs now come to the surface in Reservoir canyon and at and about the village of Moenkopi and at Moa Ave. Also at Tuba two sets of springs come to the surface, one northwest of the government plant and one northeast of it. The northwest springs are now covered over to furnish the water supply for the city, so I could not examine it. The northeast springs, several in number, gush forth in sand-elevating, bubbling springs. Both sets raise large volumes of water to the surface. Each set of these springs has a large dam to impound its water and hold it for the purpose of irrigation. Two reservoir dams have also been constructed in Reservoir canyon and one large dam in the Moenkopi wash for the same purpose, these also impounding the surface water that descends the washes. A careful husbanding of the water from these sources is now planned

FAUNA AND FLORA.

FAUNA. The Tuba section is the home of snakes, rodents and lizards, mostly of the bright-tinted type. The snakes are mostly rattlers (several different species) and bull snakes. The rodents are field mice, field rats, prairie dogs and rabbits The common rabbit and the prairie dog burrow; and the kangaroo rat, pouched rat, drumming mouse and pack rat make their nests about scattered clumps of brush and in rock crevices The rats and prairie dogs are too numerous, but both the jack and common rabbits are scarce, having been practically all killed off with some disease a few years ago. The coyote is too plentiful and is a pest to the shepherds. Gray wolves are occasionally seen. Both red and gray foxes are now and then seen crossing some ridge in the distance. Years ago the antelope and mountain sheep and deer roamed the region, but are now extinct or driven from their haunts. Some of the other animals found in the region occasionally are skunk, white weasel (lives on prairie dogs, mice, etc.), striped cat, badger, porcupine (lives on roots, bark of trees and piñon nuts), lynx, cougar (very rare), blue fox (very rare), bear (very rare), pine squirrel (also very rare), chipmunk, gopher and mole (in the Tuba-Moenkopi meadows). The following birds visit the region or make it their home: Clark's jay, English sparrow, Stellar jay, road runner, robin, snowbirds, rock wren, humming bird. pine squawker (a bluebird, very numerous), red-topped woodpecker, brown woodpecker, western bluebird, cowbird, yellow-headed blackbird, red-winged blackbird, rice blackbird (brown grackle), raven, crow, several species of hawk, burrowing owl, sparrow hawk, buzzard, bald eagle, killdeer, jacksnipe, brown-legged plover, yellowlegs, sandpiper, blue-winged teal, dadchick, canvasback, mallard, sandhill crane and meadowlark. (The waterfowl were seen about the impounded water about the dams at Tuba and in Reservoir canyon in October, 1918.) Sheep, goats, horses and cattle now graze on grass by the water holes and browse on the scanty brush.

FLORA. The flora of this region is of the arid type. Weather-beaten cottonwoods grow at Moa Ave and in the Moenkopi wash and are cultivated in groves at Tuba; also, quite a grove of scattered cedars (*Juniperus virginianus*) and junipers (*J. occidentalis*) are to be seen about four miles north of the Indian school, with a scattered cedar here and there, and once in a while a piñon (*Pinus edulus*). Goldenrods, Compositæ plants, rabbit brush and sagebrush (*Artemisia*) grow in favored locations. Yucca (*Yucca baccata* and *Y. angustifolia*) and cactus are now and then seen. Rushes and flags abound in the ponded areas. The common reed (*Phragonites communis*) is found about the northeast reservoir at the school and in Reservoir canyon. Round cactus (*Mammularia* sp.) and greasewood (*Sarcabatus*) are also to be found here and there, the latter in areas bordering semiwet places. The Maricopa lily grows profusely on the sand dune area east of Reservoir canyon. Native tobacco and the Hopi cotton (*Gossypium hopi* Lewton) also grow in the region. The latter is extensively cultivated by the natives. Clumps of the Arizona Jimson are seen in protected places. Wild flax grows toward the Little Colorado river. Also, following rains, short-lived, usually brilliantly colored flowering plants of various species spring up in favored spots, forming pleasing spots of color. The Indians are said to use 144 species of plants for food, medicine, dress and architecture or in their religious ceremonies. In their fields they cultivate about 25 species of plants, some of which they have obtained from the white man.

CLIMATE.

The mean annual temperature at Tuba is about 52 degrees. The mean for July, the warmest month, is 77 degrees; of December, the coldest, 30.5. The highest temperature is in the neighborhood of 100 degrees; the lowest in the neighborhood of 0. The highest temperature yet recorded by the weather record at Tuba is 108 degrees and the lowest —13. The nights are most always cool and the days warm to hot. Frost has killed vegetation as late as June and as early as September, but this is exceptional. Snow seldom lays on the ground more than a few days. There are about 250 clear days per annum, with the prevailing wind blowing almost continually from the southwest. The average precipitation ranges from 5 to 10 inches, being less than 3 inches in 1901 and exceeding 12.5 inches in 1906. May and June are dry months. July, August and September are the rainy summer months, and the winter months of most precipitation are November, December, January and March. At Kayenta, eighty miles north of Tuba, only fleecy clouds were seen three days in the month of June, 1919, and Tuba was no better favored. As April, May and June are the growing months for crops, it becomes very evident that crops can be raised only by irrigation. The climate is one of the most healthful in the United States.

HABITATION OF MAN.

The first white people to visit this region was the expedition sent out from Moqui (Hopi) on an exploring expedition by Francisco Vasquez de Coronado in 1540. This expedition, headed by Don Garcia Lopez de Cardenes, went northwestward, most likely along the ancient Hopi trail, as their guides were Hopis. As a result of this northwestward march they discovered the Grand canyon. As the trip out had consumed twenty days and their provisions

were exhausted, they then returned, describing the canyon to Coronado on their return in the glowing terms:[7] "It is a great river whose banks 'extended three or four leagues into the air' and are 'broken into pinnacles higher than the tower of the cathedral of Seville.'" If Cardenes followed the Hopi trail, as it is supposed he did, he was undoubtedly at the Indian village of Moenkopi and went to the canyon a little westward from it. He and his party, at least, crossed the area covered by the Tuba map herewith. If Cardenes saw the village, as is supposed, it was too small to receive notice in his account of the expedition made to Coronado and the Spanish government.

In 1583 Antonio de Espejo and four white companions went directly west from the Moqui (Hopi) pueblo of Awatobi (Aguato) on a journey to Bill Williams fork in search of some mines which the Indians had told him about. They left Awatobi April 30. His route lay over the old Hopi route westward, then directly across the San Francisco mountain belt to Bill Williams fork. After examining the mines there he returned to Zuni by a different route some time in May. It is quite likely that the "Ojo Triste" mentioned in Luxan's account of the itinerary was one of the Moenkopi or Tuba springs.[8]

On Friday, November 17, 1598, Marcos Farfan de los Godos, a captain under Oñate, and eight companions set out from Moqui to discover some mines reported to be thirty leagues farther to the westward These were the same mines Espejo had previously discovered December 8 they returned, bringing flattering reports Their route lay past Tuba and Moenkopi Their itinerary states

"Traveling on for two leagues along the mountain range, which was covered with snow (in all fourteen leagues—fifty or sixty miles—out from Moqui), they camped for the night on a slope where was found a small amount of grass for the horses. They camped without water. After they had unsaddled the horses and placed the sentinels, two of the Indians whom they were taking as guides said that they knew where there was water very near, and they wanted to go and bring some in some gourds. But the witness did not give his consent, as he feared they would flee unless accompanied by a trustworthy person, and accordingly Capt. Alonso de Quesada went with them.

"He took the Indians ahead of him, and after traveling about three arquebus shots from where we were lodged the Indians saw lights and dwellings, and signaled to the captain that they were the Jumana Indians. The captain, finding himself so near, told them to go over there, and having arrived there he found many Indians and Indian women in four or five rancherias, who surrounded them with their bows and arrows The captain told them that he had a message for them; that he was not coming to do them harm, but instead to give them what he had. Thereupon they were reassured, and two Indian chiefs of the said rancheria came on with the captain and friendly Indians to where the witness and his companions were. The witness treated them very well, showing them marks of friendship, caressing them, giving them beads and other presents. He then sent them back to their own rancherias, telling them by signs that they should reassure the rest of the people, because they were not going to injure them but to be their friends and to find out where they secured the ore, which the witness showed them.

"Next morning the witness and his companions went to the said rancheria, which he found deserted, there being in it only the two chiefs and a woman. They received them with signs of gladness, and as a token of peace gave them pulverized ore and a great quantity of ground dates (*datil*), which is their food, and a few pieces of venison. The witness in return gave them

7. The journey of Coronado, 1540-'42; translated and edited by Parker Winship: A. S. Barnes & Co.; 1904.

8. Spanish explorations of the Southwest, p. 187.

more beads and presents, and begged them to go with him to show him where they got the ore. One of the Indian chiefs complied willingly."[9]

The *Ytinerario* gives the place as "Rancheria de los Gandules," which has been identified with Moenkopi (see below); but gives it on the wrong side of the San Francisco peaks. This is the first mention of these Indians having intimate contact with white men.[1]

Oñate also visited Tuba and Moenkopi on his journey to California from Moqui in 1604, following the route of Farfan and Espejo. He found the place inhabited, but so insignificant that he dubbed it the derisive term, "Rancheria de los Gandules."[2]

Many other explorers also likely visited the place without leaving a record of their trips, or their manuscripts still remain unpublished. And more recently following the stages of time, Spanish explorers, Mormon emigrants and government scientific expeditions have visited the site.

F. W. Hodge also comments on this region as follows [3]

"Moenkopi ('place of the running water').—A small settlement about 40 miles northwest of Oraibi, northeast Arizona, occupied during the farming season by the Hopi. The present village, which consists of two irregular rows of one-story houses, was built over the remains of an older settlement, apparently the Rancheria de los Gandules seen by Oñate in 1604. Moenkopi is said to have been founded within the memory of some of the Mormon pioneers at the neighboring town of Tuba City, named after an old Oraibi chief. It was the headquarters of a large milling enterprise of the Mormons a number of years ago.

"Concebe. Garcés (1775-'76), quoted by Bancroft Arizona and New Mexico, 137, 395; 1889. Moencapi. Coues, Garcés Diary, 393; 1900. Moen-kopi: Mindeleff, in 8th Rep. B. A. E, 14; 1891. Moqui Concave *Ibid.* Moyencopi Bourke, Moquis of Arizona, 229, 1884 Maube. *Ibid.* Muenkapi: Voth, Trad. of the Hopi, 22; 1905 (correct Hopi form). Munqui-concabe· Garcés (1776), Diary, 393; 1900. Muqui Concabe *Ibid.*, 394-395 (Yavapai form). Rancheria de los Gandules Oñate (1604), in Doc. Ined., XVI, 276; 1871 (apparently identical)."

On account of Moenkopi-Tuba having abundant springs, for ages it apparently has been the crossroads point for the whole arid section between Moqui and the Colorado river and between the San Juan region and the San Francisco peaks and the region beyond to the southward. In the region about these two places are many village ruins, which indicate that a peaceful, agricultural people have inhabited it at times. The ruins also indicate that these villages were destroyed or abandoned as a result of the approach of more savage peoples. Moreover, that it received so scant a mention by the early explorers is due to its smallness, or to the fact that it was for the time temporarily abandoned. The settlers of the villages were undoubtedly Hopis (Moquis) formerly, as now, as the curios found in the debris and the tribal traditions of the Hopis indicate.

As formerly, this place in historic times has served as a station on routes across the plateau. Piutes, Walapai and Havasupai have utilized the Tuba route in their trading and foraging expeditions and marauding, hunting enterprises. This route was also followed by the white explorers, adventurers and

9. Spanish explorations of the Southwest, pp. 240, 241, and footnote, p 241.
1. The Ytinerario, loc. cit., p. 276.
2. Loc. cit., 268-280; also Collection de Documents Queditos (Ined.), XVI (1871), p. 276.
3. Handbook of American Indians, part 1, p. 919.

emigrants, as we have seen. As time passed the Piutes began to raid the cornfields and homes of the Hopis there. Then came the superior Navajo, who dispossessed both Hopi and Piute. The oasis was, therefore, practically abandoned by the Hopis, and the Piutes retreated to the region of the San Juan. From about 1750 to the days of men now living, the Moenkopi fields were cultivated only as it was thought safe for the Hopi farmers to come from their homes forty miles away at the well-protected village of Oraibi to put in the crops and attend them, and then return to the home village when the crops were gathered, the Hopi women seldom visiting the place. Garcés, in 1776, found on the oasis a "half-ruined pueblo and some crops near a spring." He further stated that the people who cultivated the fields were Hopis, "they coming to cultivate them from the same Moqui pueblo (Oraibi), which is so large."[4]

From the traditions of the Hopis it is learned that a few of the Hopi men came and farmed on this oasis each year, some possibly staying year by year. A few Piutes and Navajos appear also to have had fields there from time to time. As late as 1874 Jacob Hamblin found "only one Piute family and one Oraibi woman there."

In the early seventies the "saints of the Mormon Church were called to settle in Arizona," and crossing at Lee Ferry, Pierce Ferry and the "Crossing of the Fathers," they made settlements, under Jacob Hamblin and others, in the Navajo-Hopi region, Mr. Hamblin having previously made seven excursions into the region between the years 1858 and 1871. The emigrants in 1873 turned back to Utah on account of disastrous experiences in the Painted Desert, leaving but one family at Moenkopi. In 1875 this family was forced to leave by the Navajos. A permanent settlement, however, was made there the following year. The "saints" first cultivated the abandoned fields of the wash. Then later the lands of Moa Ave, Tuba and Reservoir canyon were brought under cultivation, and permanent settlements were made at the first two places. Then followed years of hardship, for though the fields yielded fruit, garden truck, corn and wheat, everything else had to be brought overland from Utah to the place, or from Albuquerque, N. Mex., 370 to 450 miles. Their building material, except rock and earth, had to be hauled from the San Francisco peaks, 70 miles distant. Moreover, the area that could be irrigated was small in comparison with the population that had to depend on it for a living. In addition there was more or less trouble with the Navajos; also at times, to keep peace with the Indians, certain Navajos and Piutes were permitted to live on the oasis, which though keeping the peace, also divided the sustaining crops among that many more families.

With the coming of the Mormons, the Hopis, under Tuba (after whom the town of Tuba City gets its name), began to return to the lands of their ancestors. The Moenkopi people state that Chief Tuba went to Salt Lake City and prevailed on the Mormon Church to send the white settlers to the region so they would be protected from the Navajos and Piutes by the hand of a stronger race. From records it also appears that Tuba and his family were the only Hopis living at Moenkopi in 1880. By 1903, 100 Hopis were residing there, and now over 300 make their home at Moenkopi.

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4. Translation from Coues (Elliot), loc. cit., II, p. 358.

In 1903 the government "purchased" the Mormon settlers' rights to the lands at Moenkopi, Tuba, Moa Ave and Reservoir canyon for $45,000, and has since made Tuba the headquarters of the western Navajo Indian agency and school, the Mormon pioneers moving to other points in the upper Little Colorado valley, and both the government and the Indians, as well as the pioneers, have profited by the change.

This accounts, in brief, for the known occupation of Moenkopi and Tuba; but the ruins show that the place was inhabited long before the coming of the Spaniards or before the time of any Indian then living. Below is a description of the ruins examined by the writer.

Ruin of Honogee. Across the wash northeast of the village of Moenkopi, on top of the mesa, about directly east of the day school, is the extensive ruins of Honogee, built in the form of a rude square. Parts of its walls are still standing, which indicates that it is younger in time than the other ruins of the region, as will be noted later. Moreover, the Hopis told the writer that this was the village where they made their last stand against the Navajos, and consequently was their last abandoned village. Near to it, on the side of the bluff overlooking the canyon, are also the ruins of a series of cliff houses under an overhanging wall-roof. Five rooms are still intact, with the little, almost square doors still showing. They are built of rock, cemented in with adobe. These houses, with the ruin on top of the mesa, were unquestionably built by the Hopis, and were also most likely constructed since the coming of the men of Coronado.

No. 1. Ruin west of north of the agency. This is the remains of a small ruin about a half a quarter of a mile west of north of the agency office. It was perched on the down slope from the bluff bench west of the Tuba grove and fields, only a short distance from the bench. The building material was all of adobe and has all been removed by erosion, so that now only fragments of pottery mark the site. The pottery is strictly of the Pueblo type. Probably no more than seventy-five people ever lived in this village. Its position is notable for its lack of defense, as an enemy on the bench could have commanded its walls.

No. 2. Double-toothed butte ruin. This ruin is about a mile northeast of the school, in the Castle Butte region. A considerable building has occupied the space between the "two fang roots of an inverted, double-toothed" butte. It was made of limestone, which was carried to the place from a distance of more than a mile. A few feet of the foundation wall is now still in place. The remaining stones of the wall have mostly slid down the approaching incline to the north and are now scattered about the foot of the butte. This building was probably a watchtower. There is also evidence in pottery fragments and limestone slabs that a considerable village faced the butte on the east and south. The rooms evidently were several stories high, as niches cut in the soft sandstone for shelf space and the placing of beams are as high as twenty feet from the base of the butte. Some of these shelf spaces have Indian pictographs chiseled on their walls, but some "civilized" man has spoiled them by cutting his name over them. On the west side of this same butte, eighteen feet from the ground, two cave rooms have been cut out of the soft sandstone so that they join each other like a double pocket. The front has now been

mostly broken off. The back part of each room also has a chiseled space in which the dwellers probably set their religious things. There were also chiseled spaces for beam supports. There were also glyphs on the walls of these rooms, but, as above, some one has chiseled his name across them, much disfiguring them.

No. 3. A ruin east of a small butte about a quarter of a mile east of No. 2 was examined. This butte has a butte less than 100 feet both to the west and to the northeast of it. A watchtower was probably on it when the village was occupied. There is some evidence that the village once completely surrounded the butte. The village was probably of adobe, as all signs of it except the great quantity of broken pottery of the Pueblo type have been removed.

The people of villages Nos. 2 and 3 evidently farmed in Reservoir canyon, which is about a mile distant to the eastward. They also likely got their water supply from that canyon. The site of these villages is a most desolate, sand-swept area Certainly no people would have gone to such a place to make a home except for defense For this purpose the villages were admirably situated, except that an enemy might capture their water-supply source both at Tuba and in Reservoir canyon and thus drive them from their stronghold.

No. 4. This is the site of a long ruin, running in an east-and-west direction along the north line of the agency fence from a point 300 yards west of the northeast corner of the government inclosure, west of the agency road, westward several hundred yards Much of the old site is now covered with dune material. At two places, however, two plazas can be made out, and also enough to show that the village ran in an east-and-west direction. There are many pottery fragments, also a few stones are scattered about, but not enough to have been of use in constructing the walls. The pottery fragments cross to the south of the fence to a considerable distance at several places and also show to the north of the dune ridge north of the fence, which is north of much of the pottery exposures. This village was very large, containing probably 1,000 souls, provided it was all occupied at one time. How long ago it was occupied cannot be conjectured, but it was so long ago that not a part of the wall now shows in place It was constructed in a very poor place for defense, but probably, on account of its size, its walls made it impregnable. The water supply was situated about half way between the northwest and northeast springs at Tuba and adjacent to the lands that would be irrigated from those springs by them, but it must have been a sandy, dust-swept place in which to live.

No. 5. In the flat about a quarter of a mile nearly west of the Tuba school and agency there is a large mound of adobe to sandy clay, at the base of which there is scattered ancient pottery fragments. This seems to indicate that the mound is probably an ancient village site.

No. 6. About half way between the agency and the mound mentioned in No. 5 above, a dry arroyo has removed the most of an ancient village site. Only an area of probably twenty feet in diameter of the floor of the once village home in a bend in the dry gully is now left. This is literally covered with fragments of ancient pottery, all beautifully covered with decorations. At this date the size of this once populous village can only be conjectured.

No. 7. Just over the fence east of the Presbyterian mission at Tuba, on a slight rise of ground is the remains of a ruin represented almost wholly by pottery shards. It has been a very large village, though only a small part of the original site is now bare of dune material. Judging from the abundance of broken pottery, it was either inhabited for a long time or a large number of people lived there simultaneously.

No. 8. This ruin is just below the wind-blown sand dam that forms the third reservoir in Reservoir canyon. It was built to the east of Reservoir creek, on an adobe flat abutting a Navajo sandstone bluff to the eastward. Only a remnant of the village now remains in its representative pottery shards, but it probably was an extensive village. The place was ideal. There are farm lands below in the valley and plenty of water in the adjacent springs for all uses.

No. 9. This village was below No 8 (above), on Reservoir canyon. Its site was elevated on a stone-floored flat to the east of the canyon. The pottery pieces and the adobe remnants of the village have practically all been removed by wind and water, so that its size cannot now be conjectured.

A salt cave has been worked near Moenkopi.

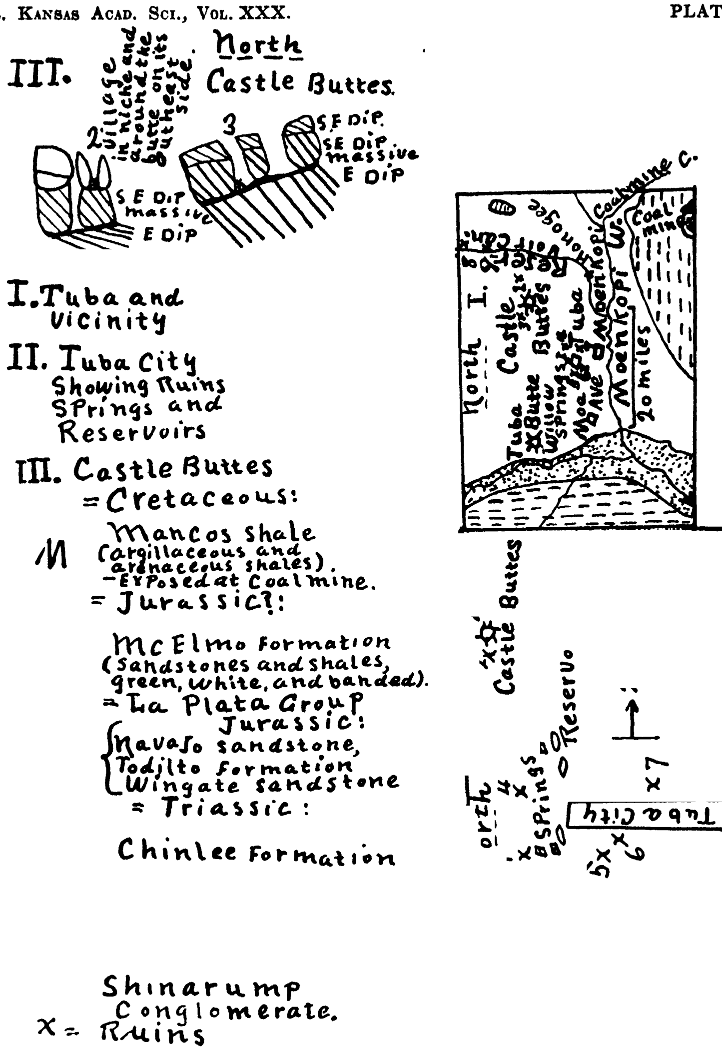
There are villages in the vicinity of Moa Ave and at several other places in the vicinity of Moenkopi and Tuba, but time would not permit the writer's visiting them.

From the criteria at hand, either a numerous people lived on the Tuba-Moenkopi oasis at one time, or a small population lived there many hundreds of years; and the evidence leans toward the latter. Why they abandoned the place is very evident. An ever-encroaching enemy made it unsafe to live there.

THE KAYENTA REGION, ARIZONA, AND ITS RUINS.

The Kayenta region, as here considered, lies between latitude 36° 30′ and 37° and between longitude 110° and 111°. It is a much-dissected, canyon-cut plateau In the main it is the region drained by upper Laguna creek and its tributaries. It comprises the region between The Monuments (mainly between Comb ridge) on the north and Black mesa on the south; Church rock on the east and the Segi mesas on the west. It is composed of a great valley of eight or nine miles in width in the vicinity of Church rock, but tapering to a point at Marsh pass, while deeply cut tributaries enter it from all sides but the east. Comb ridge, at the north, stands 500 feet above the valley floor; and Black mesa at the south, 12,000 feet; while the Segi mesas close in the western front with probably a similar elevation. The mesas to the westward are red; those to the south, due to the included shale and coal, are black. The north and west fronts are Jurassic rocks, with occasional Triassic patches. The south front is closed in by Cretaceous rocks. The road from Tuba to Kayenta from Red lake northward runs about on the contact line between the Jurassic and Cretaceous. At Marsh pass the rocks are high pitched, as are usually the rocks of Comb ridge. The rest of the rocks are of moderate dip. The dip is usually southward to southeastward. To the north of the valley are The Monuments, the headstones which for ages have been marking time in earth's giant graveyard. Also at hand are Porras dikes, Church rock, Chaistla, Slim rock and El Capitan, which act as guardians of the valley; the latter, a giant volcanic plug, stands 1,225 feet above the valley floor in which it is situated.

TRANS. KANSAS ACAD. SCI., VOL. XXX. PLATE II.



The Tuba-Moenkopi region and ruins, Western Navajo reservation, Arizona.

In addition, Comb ridge is composed of knobs, comb teeth, buttons and buttes. On the whole the region is surprisingly picturesque.

This beautiful region seems never to have been visited by white men till the time of people now living. No settlement was made in it till 1909. It is believed that the Spaniards visited it; but if they did, no record has been preserved, or at least published; a ruin twenty-five miles to the westward has an inscription in it, "Ghos, 1661, Ano," which shows that some Spaniard was in that section at that date, leaving this meager record. The Mormons seem to have been the first white people to go through Marsh pass. Later a government military road ran through it. In 1909 Messrs. John Wetheril

and Clyde Calville and the family of the former moved to the valley and erected the store and residence of Wetheril and Calville, naming it Kayenta (a corruption of Tyende, peculiarly uttered), after the Navajo name for a pothole in Laguna creek near by—the Indians' name meaning "bottomless hole." They then got a post office started, the mail coming by pack horse from Chin Lee, sixty miles distant. Later, then, the government established the Marsh Pass Indian boarding school twenty rods north of the Wetheril and Calville store. A missionary soon followed; then a government stockman; and still later the firm of Buckbee & Verkamp started a store at the place. The civilized population of the place now comprises about eighteen people.

When the first white men visited the region there were many pools and small lakes both in the main valley and in the canyon of the Segimesas; but about 1881 a stream, now known as Laguna creek, began to cut back from Chinle creek to the eastward. It has now not only drained all the lakes and pools, but has cut a canyon fifty feet deep through the former loose valley fillings, and now the water that once stayed in the region runs rapidly away. Reclamation work of the government is now endeavoring to erect dams in the creek to save the water for irrigation. Should the project succeed the valley will undoubtedly become one of Arizona's rich spots.

Only two subjects relating to this region have ever been touched—geology and archæology. The geology was handled by Mr. Herbert E. Gregory, of the United States Geological Survey, by whom the following papers have been published: "Geology of the Navajo Country";[5] "Water Supply Paper on the Navajo Country";[6] "The Black Mesa Coal Field of Arizona";[7] and "Garnet Deposits in the Navajo Reservation in Arizona and Utah."[8] Several parties have done archæological work in this region, principal of whom were the Wetherils, John and Richard, the Hyde Exploring Expedition, Prof. Byron Cummings, and the exploring expedition under Messrs. Alfred Vincent Kidder and Samuel J Guernsey. The archæological works bearing directly on the region so far published are: "Preliminary Report on a Visit to the Navajo National Monument"[9] (ruins in Segi canyons); "The Ancient Inhabitants of the San Juan Valley";[1] and Cummings, 1910, "The Kivas of the San Juan Drainage";[2] "The Prehistoric Ruins of the San Juan Watershed in Utah, Arizona, Colorado and New Mexico";[3] "The Sandal Stone";[4] and "Archæological Explorations in Northeastern Arizona."[5] For a complete bibliography

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1. Cummings, Byron, The ancient inhabitants of the San Juan valley: Bulletin of the University of Utah, Second Archæological Number, vol. iii, No 3, pt 2; Salt Lake City; 1910.

2. Cummings, Byron; The kivas of the San Juan drainage: American Anthropologist, n s, vol. xvii, pp. 272-282; Lancaster, Pa., 1915.

3. Prudden, T. Mitchell; The prehistoric ruins of the San Juan watershed in Utah, Arizona, Colorado and New Mexico: American Anthropologist, n. s, vol. v, No. 2, pp. 224-288; Lancaster, Pa, 1903.

4. Wetheril, Richard; Sandal stones: The Antiquarian, vol. 1, p. 248; Columbus, Ohio.

5. Kidder, Alfred Vincent, and Guernsey, Samuel J.; Archæological explorations in northeastern Arizona: Bulletin 65, Bureau of American Ethnology; Washington, 1919.

of publications bearing on the archæology of the Navajo country in general, the reader is referred to the last-named paper above, "Archælogical Explorations in Northeastern Arizona," pages 221 to 223.

All the archæological work so far done in the region has been in the main in the examination of the larger ruins of Keetseel and Betatakin and other ruins of the Segi region and adjacent canyons. It is the purpose of this paper to give a description of the smaller ruins, which are found to be surprisingly numerous. Only a brief mention will be made of ruins previously described.

In order to give a better understanding of the region, a short sketch of the geology and natural history of the country in general will be here appended, followed by a description of the respective ruins so far as examined.

GEOLOGY OF THE TUBA-KAYENTA REGION.

The formations represented in the region are the Quaternary, Mesaverde, Mancos, Dakota, McElmo, Navajo sandstone, Chinle, and Shinarump conglomerate. These, with some additions, are the same as those represented in the Tuba region, previously described Where previously given in detail, the description of the formation will be condensed to the fewest possible terms. The other formations will be given in detail.

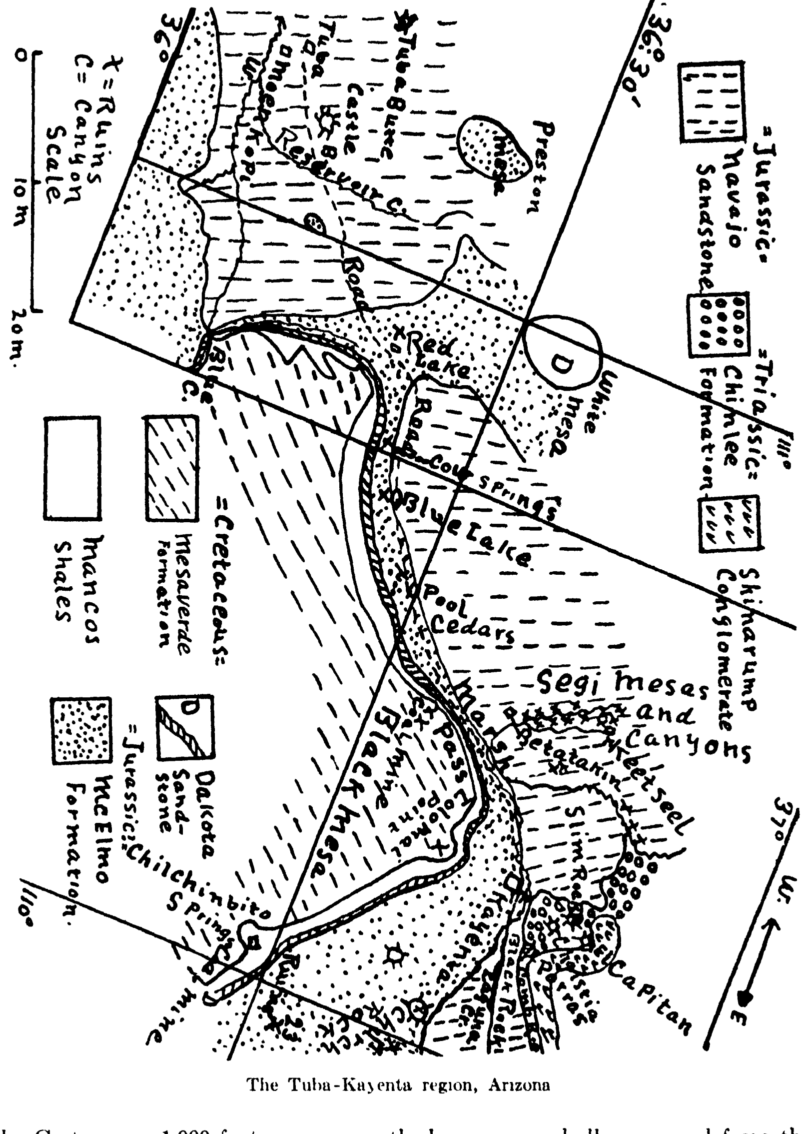
QUATERNARY (not mapped). The Quaternary of this region, which includes the recent, is composed of two series of material—dune material and the valley fillings.

The dune material covers a great part of the country between Tuba and Red lake, and seems in a great part to be disintegrated McElmo sandstone; also in the lee of wherever the McElmo is exposed, and in the regions covered by it, there are extensive dunes. Canyons are also now being filled with this dune material, and this process has been going on for ages. Large dunes also occupy the lee of practically all the mesas and buttes on their northern and eastern sides. The prevailing wind is from the southwest and is usually high a great part of the year. At some places sand banks reach to the very tops of the buttes and mesas and form the means by which they can be scaled. Many of the flats and benches are dune swept, in fact, the whole region might be termed a sand-dune country. How long these dunes have been accumulating cannot be determined, some of the largest probably throughout Quaternary time. The recent piling of the sand has covered up many of the ancient ruins, some of which are now being uncovered by the wind. Others will probably remain totally submerged in the shifting sand for ages.

The valley fillings cover the floors of the inner valleys often to a depth exceeding fifty feet, and often fill the floor of the whole canyon space. In the flatter regions they widen out. The fillings in Laguna creek valley two miles east of the school are several miles wide. Opposite the school they are seventy-five feet in thickness. On the route from Marsh pass to Tuba, in the valley followed by the road, there are clay-adobe fillings of great depth, filling most of the whole valley. The fillings of the Laguna creek section are being rapidly cut into canyons till the country is hardly passable in places. The fillings from Marsh pass to Tuba are also being cut into by washes.

A close observation shows that a deep cutting process began in this region some time in the Tertiary and continued uninterrupted till probably in the Quaternary, when the incising process was arrested. In this denuding, all

TRANS. KANSAS ACAD. SCI., VOL. XXX. PLATE III.



The Tuba-Kayenta region, Arizona

the Cretaceous, 1,000 feet or more in thickness, was wholly removed from the entire region north and west of Marsh pass and Laguna creek, also west of the Tuba-Kayenta wagon road south of the pass. The great valley of Laguna creek and the gorges of the Segi canyons were then cut, as were the cross and lateral valleys to the north of that great valley which to-day exposes the jutting teeth of Comb ridge, the volcano plugs and The Monuments. Then there set in a refilling of the valleys, which continued to our own time.

Concerning this filling of the valleys, Dutton, who with Powell examined the plateau region, 1878-1880, says:

"Most of those lateral canyons . . . are slowly filling up with alluvium at the present time, but very plainly they were much deeper at no remote epoch in the past. The lower talus in some of them is completely buried, and the alluvium mounts on the breasts of perpendicular scarps. In some cases a smooth floor of alluvium extends from side to side of what was originally a canyon valley." [6]

When the first white people came to the Marsh pass - Laguna creek country, there was no Laguna creek. The valley and canyon floors were a vast plain, dotted with lakes and swamps. A map made of the region in 1881 shows no stream leading out of it Hunting parties frequented the region to kill ducks in the swamps and marshes; and the government road led through the pass over the marshy flats, hence the name "Marsh pass." Then Laguna creek began to cut back from Chinle creek thirty miles to the eastward. Year by year it extended its possessions till to-day it ramifies every part of the inner valley and the Segi canyons, has drained all the ancient pools, swamps and lakes, and has the whole country cut up with a maze of lateral, straight-walled chasms fifty feet or more in depth. And the Tokas Jay, the stream leading northward up the valley along the road toward Marsh pass from Moenkopi wash, will cut up this valley and destroy its lakes and pools, as Laguna creek has done in the Kayenta region, unless man brings about some means to stop its devastating process.

Many people, including the geologist, Herbert E Gregory, believe that the aggrading of the valley floors of this region was due solely to climatic changes —little rainfall and the action of the wind. They also believe that the cutting of the valley fillings is due to the overgrazing of the region and the making of paths and roads Mr. Gregory's opinion is as follows [7]

"During the last twenty or thirty years, in consequence of overgrazing, and probably, too, of climatic change, the alluvial floors of canyons and washes have been trenched by streams, and the normal valley profile has been changed from a flat-floored, rock-walled gorge to a valley, including an inner canyon ten to fifty feet deep, whose walls are of alluvium . . This new development has resulted in enlarging the amount and increasing the permanence of stream flow. A number of perennial springs and seeps issuing from the base of the alluvium in the new-made canyons and arroyos have been added to the reservation within the last thirty years, and the amount of surface water has been increased accordingly at the expense of the ground water supply."

And again Mr. Gregory says [8]

"That the streams of the region were formerly aggrading their canyon floors and that they are now trenching the valley fill are facts abundantly supported by field evidence. If the period of rock canyon cutting is termed the 'canyon cycle,' the period of aggradation and degradation may be considered, respectively, the epicycle of alluviation and the terrace epicycle. *The recency of both periods is indicated by the presence of corn cobs and pottery buried beneath terrace gravels and exposed in the banks of present streams* and by the old cottonwood trees of the upper Moenkopi valley, whose trunks, buried to depths of ten to thirty feet, have recently been excavated.

"The date of the beginning of the terrace epicycle through which the region is now passing may be fixed with a fair degree of approximation. The lake in Bonito canyon, described by Simpson[9] in 1850, has disappeared, and

6. Dutton, C. F.; Tertiary history of the Grand Canyon districts: U. S. Geol. Surv. Mon. 2, pp. 228, 229; 1882.

7. Water resources of the Navajo country: loc. cit., p. 100.

8. Geology of the Navajo country. loc. cit., pp. 130-132.

9. Simpson, J. H.; Journal of a military reconnaissance from Santa Fe, N. Mex., to the Navajo country (1850), p. 110.

the present arroyo is sunk twenty to thirty feet in sands and clays, including layers of peat. In Laguna canyon the lakes shown on the Marsh pass topographic map, published in 1882, are drained, and their floors are deeply trenched. According to the Navajo legend the Segi region was bewitched in 1884; the farm lands were cut out and the lakes vanished. Certain events are well authenticated. In 1880 a perennial water body existed in Tyende valley fifteen miles east of Porras dikes, and in 1893 a road traversed this valley from its mouth to Tyende, crossing and recrossing the stream at points now marked by arroyos twenty feet deep. In 1894 the flat-floored alluvial floor of Walker creek was occupied by Indian farmers and the bed of the Chinle was cultivated; in 1913 the terraces on Walker creek were eighty feet above the stream and the Chinle flowed between alluvial banks 100 feet high. Since the Mormon occupation of Tuba (City) in 1878 the Moenkopi has intrenched itself in alluvium to depths of fifteen to forty feet. The terraces on Pueblo Colorado wash at Ganado date from about 1880. At Keams canyon the deep alluvial fill is being removed so rapidly that the location of roads and buildings has become a serious problem. Accounts of prospectors, pottery hunters, government officials, Navajos and Hopis agree in placing the formation of terraces within the last twenty-five or thirty-five years. During the course of my field work in this region, in 1910 and 1909-1913, significant changes have been effected in the width and length of alluvial terraces. The floods that follow showers in July and August perform an incredible amount of erosion. It is unsafe to stand near the bank of a stream while torrents of liquid mud carrying trees and blocks of alluvium are passing.

. . . .

"*Cause of terracing* The nature of the change in physiographic environment that called a halt in the work of rock canyon cutting and introduced the epicycle of alluviation is not clearly understood. As I have shown in another connection,[9] a pause in regional uplift or a change to a more humid climate would permit wider distribution of gravel and better grading of streams. That the crust of the earth in northern Arizona is unstable is indicated by the recurrence of earthquakes, but no direct evidence of movement within the past few centuries has been recorded. The stream profiles are now greatly oversteepened—a condition which doubtless existed during the epicycle of alluviation. The contrary view involves the improbable assumption that the present valley gradients have resulted from differential uplift of large amount since the cliff dwellers occupied the country. A climatic rather than a tectonic cause for the epicycle of alluviation is thus suggested.

"Change in stream habit from aggradation to degradation, introducing the terrace epicycle, is best explained also on the hypothesis of climate fluctuation. Terracing appears to be universal over the Colorado plateaus and adjoining regions at the present time, and an uplift sufficient to produce the results accomplished in the last thirty or thirty-five years would need to have been almost continual in extent and to have been abnormally rapid. The rainfall records at Fort Wingate and at Fort Defiance show no significant cycle, either wet or dry, for the years 1880 to 1885, the period during which the vigorous down-cutting became dominant, but the rainfall in southern California for 1883-'84 was the heaviest ever recorded. Measures of fluctuation in mean annual rainfall have, however, little significance in this region. Erosion results from sudden violent showers followed by unobstructed run-off, and, if suitably distributed, in time an annual rainfall of half the normal amount may be more effective in denuding the land than a precipitation of twice the normal. Under present conditions terraces are produced by floods, the streams aggrading during periods of low water and degrading when the volume is increased—a statement, however, which implies nothing as regards cyclical conditions of aridity and humidity. It is important to note in this connection that the balance between aggradation and degradation is nicely adjusted in an arid region where the stream gradients are steep, and that accordingly

9. Gregory, H. F.; The formation and distribution of fluviatile and marine gravels: Am. Jour. Sci., 4th ser., vol. 39, pp. 487-508; 1915.

small changes in the amount of rainfall, its distribution, or the character of the storms and changes in the amount and nature of the flora result in significant modification of stream habit. Even the effect of sheep grazing is recorded in the run-off, and this influence combined with deforestation has been considered by many investigators as the sole cause of recent terracing in the plateau province. *For the Navajo country these human factors exert a strong influence, but are not entirely responsible for the disastrous erosion of recent years. The region has not been deforested; the present cover of vegetation affects the run-off but slightly,*[1] *and parts of the region not utilized for grazing present the same detailed topographic features as areas usually overrun by Indian herds.*"[2]

The factors above mentioned no doubt aided in building up or degrading the fluviatile valley floors; but it would seem to the writer that possibly the main agent in causing the aggrading of the valley floors was man.

The Hopis (and occasionally the Navajos) of to-day build dams and ditches to direct the flood waters of the respective washes and also to prevent canyon cutting; also a series of check dams are often built along moderate slopes and along small washes to retard the run-off and to impound water for stock and house use. Occasionally the valley sides are terraced to prevent arroyo cutting. The dams, which are about five feet in height, are of earth, and consequently have to be put in annually. Though requiring a great amount of work, through this ponding of water and the diverting of washes, water is furnished for much of their stock, and over 20,000 acres of land is irrigated.

In the long-ago, when this region was densely populated, as will be shown later, each little wash and flat had its village, and the water was carefully husbanded in the irrigating of the necessary fields and was impounded by reservoirs and check dams for village use At the present time more than 90 per cent of the flood water escapes down the washes. The escape of the flood water then was nil, and probably this condition existed for thousands of years As evidence that such damming and diverting of water was practiced by the ancients of this valley, fragments of check dams of loosely piled stone arranged on sloping rock benches and on the terraced floors of the washes may be seen near many of the ruins of the ancient cliff houses and villages of this region. This reduced the water run-off to the minimum As a result the *débris* brought down from the mesas by washes was left on the fields and deposited as fans over the valley flats As no water ran down the main channels, they gradually filled up Wind action no doubt played a part in filling up these valleys. However, there is no evidence that a sand dune closed any part of Laguna creek so far as examined by the writer. On the contrary, its banks are clays, pond deposits (including layers filled with snail shells), and wash material In time the drainage became wholly blocked, not because of a lack of rain water sufficient to carry off the *débris*, but because man used the accumulating waters for his own use. Outrushing washes descending from the higher areas also now and then pushed their dry fans farther and farther across the region till the valleys were wholly dammed and the excess water impounded in shallow lakes. Then by this same process the valley flats were gradually aggraded. That this valley filling occurred since the coming of the villagers is evidenced by the presence of pottery, corn cobs, kitchen refuse and occasional walls of rooms, buried beneath the filling of the terraces, now ex-

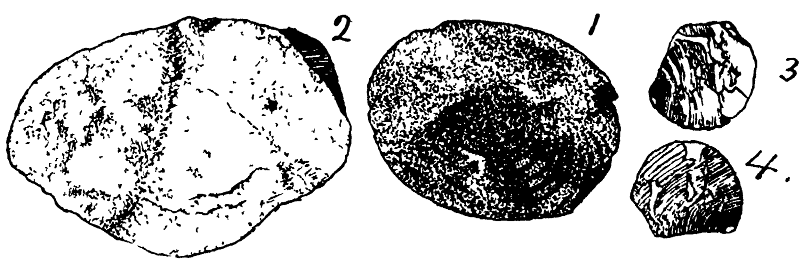
1. Loc. cit., p. 119.

2. The italics are the writer's, to show a part of Mr. Gregory's writing that will be of interest later in this work.

posed in the banks of the present streams. The villagers and cliff people then left the region. The region then remained in a state of equilibrium as they left it for hundreds of years, except that the ponded areas probably increased in depth and the fluvial, dry ridges increased in height; for, as is well known, an established condition will remain till some excessive influence (change) overwhelms it. Thus the valley aggrading continued. Then the Navajo came with his stock and the white man with his roads and trails. The grass and herbage was short-cropped and trails led down the valleys and from the mesas and mountain slopes. Moreover, but little or no water was used for irrigation. As a consequence of these changes the rainfall rushed down the almost bare slopes, collected in the trails and rushed on toward a central point in the respective valley. Along these paths (and roads) canyons were cut and permanent channels formed. By these the waters collected in the central area in sufficient volume to commence cutting a channel to a master stream. In this manner Laguna creek was formed, and in the same manner the Tokas Jay is cutting northward now from Moenkopi wash, and a branch of Laguna creek is cutting southward from Marsh pass. This cutting will continue till man again arrests its progress

This building up of the valley floor will again receive notice when the ruins of the region are considered.

CRETACEOUS. The Cretaceous is represented by the Mesaverde formation, Mancos shale, and Dakota sandstone, comprising, in the main, what is known as the Black mesa series They are all coal bearing and possess great potential value.



Fossils from the Mesaverde formation from the coal mine at Chilchinbito. No 1 is *Inoceramus* sp, and is from an impression left by a cast The others have not been identified. Drawings by Clarence Taptuka, a Hopi Indian

Mesaverde formation. This formation caps Black mesa in the area mapped. For the most part it is composed of sandstone and shales with coal. It contains much more coal than the Mancos, next described, the coal is a better grade, and the beds in general are thicker and more constant. There are several operating mines in this formation. Two thousand tons a year are mined by the government for the Keams Canyon school. A section at this mine is here given.

	Feet.	Inches.
1. Coarse sandstone and conglomerate	190	0
2. Fine, white to gray sandstone	37	0
3. Shale	1	6
4. Coal, including lenses of shale	3	8
5. Shaly sandstone and shale	3	1
6. Coal, containing two small lenses of shale	5	9
7. Sandstone	71	0
	312	0

A section at Chilchinbito Spring, twenty-two miles southeast of Kayenta, also gave the following:

		Feet.	Inches.
1.	Thick-bedded sandstone (estimated)	457	0
2.	Shale, carbonaceous matter and small lenses of coal	3	7
3.	Thin-bedded sandstone	16	0
4.	Coal	1	6
5.	Shaly sandstone	1	7
6.	Coal, including a foot stratum of gray shale	4	3
		483	11

The Marsh pass school gets its fuel supply from a mine here. Six seams of coal have been observed in this vicinity, one 9 feet in thickness.

Mancos shales. These shales outcrop all around the west, north and east faces of Black mesa as far as visited by the writer, forming a narrow black belt overlying the Dakota. Its thickness ranges from 300 to 600 feet. As suggested, it is a black shale series, though sandstone and other colored shales also occasionally met with. This formation carries much coal. At the northeast terminus of the mesa the coal is "bony" None so far examined is merchantable, though some of the seams are thick; but further south the coal becomes purer and is workable The Tuba Indian school is supplied with coal from a mine in this series A section of the formation as exposed in the vicinity of this mine is as follows

		Feet	Inches
1.	Yellow to dark arenaceous shale	11	0
2.	Coal	1	6
3.	Shale	2	0
4.	Coal with a foot lens of bone (mined)	7	6
5.	Brown and gray shale	6	0
6.	Thin beds of coal interstratified with shale	16	0
7.	Buff sandstone, followed by shale, including coal lenses	15	0
		69	0

Twelve seams of coal are known to exist in the Mancos shale of this mesa, one approximating six feet in thickness; also at all locations examined the position of the sandstone is favorable for mining.

Dakota Sandstone. The Dakota formation underlies the Mancos and overlies the McElmo (at least at the north). It is several hundred feet in thickness and forms a band surrounding Black mesa, so far as visited, with an occasional outlying patch, the largest patch being White mesa west of Red lake. It terminates at the top in a yellow sandstone which in places exceeds 60 feet in thickness and often forms the cap of outlying branches. Underneath this cap are 200 feet of white, slightly greenish, friable sandstone and sandy shale. The formation, too, is coal bearing The coal found in it in Three Mile wash south of Kayenta and at several other places along the north, northeast and west faces of the mesa seldom attain a foot in thickness. The coal was found to be very variable in extent, was always impure, and was found rather to be in short or long lenses than in seams. Also at several places examined between Chilchinbito and Marsh pass coal seams were observed to be from four or five to ten inches in thickness, consisting essentially of carbonized plants embedded in sand and clay. This was especially noticeable in the Three Mile wash district. So far as present criteria indicate there is no merchantable coal in this formation.

General remarks on the Cretaceous formation. Coal outcrops can be seen all round Black mesa, which is composed wholly of Cretaceous rocks. These

outcrops often range from three to five feet in thickness, one or two seams exceeding even that. The region is so far untouched. Professor Gregory, of the United States Geological Survey, and many other geologists estimate that this field contains eight billion short tons of workable coal, and it is the writer's opinion that it will probably exceed that amount. On account of the crumbling nature of the Cretaceous and also of the underlying McElmo formation, cliffs suitable for cliff houses are seldom formed. As a consequence, the ruins in the region covered by these formations are practically all of the village type.

JURASSIC. The Jurassic system is composed of the McElmo formation (?) and the Navajo sandstone series. The Navajo sandstone with the underlying Chinle are harder than the Cretaceous rocks and are cliff-forming of the durable type. In the regions covered by these formations are numerous cliff ruins; in fact, every canyon has its system of such ruins.

The McElmo formation is composed of soft, fine-grained, green, white and banded sandstone and shales. It fringes Black mesa at the west and north and extends far westward in the Red lake region. It easily disintegrates, and the region covered by it and in its lee is often a bad sand-dune-swept area. The formation is probably 500 feet thick.

The Navajo sandstone series is composed of light-red, fine and variegated, massive sandstone which is cross-bedded to exaggeration. It often exceeds 500 feet in thickness and covers the entire plateau west of Black mesa west of the Kayenta-Tuba wagon road, except the small area covered by the McElmo formation. The Segi and Tyende mesas west and north of Kayenta and Comb ridge are also composed of it. It is noted for its permanent cliffs, as we have seen, and for the numerous potholes on its surface, which contain water after each shower. The rock is also very porous, the retained water seeping through it to emerge as springs at lower levels.

Dinosaur tracks are reported to have been found in this formation.

TRIASSIC. The Triassic rocks exposed are the Chinle formation and the Shinarump conglomerate.

The Chinle shows north of Comb ridge, north of Kayenta, and abuts the Segi-Tyende mesas on the east. The volcanic plugs El Capitan and Chaistla protrude up through it. It is composed of shales, with thin sandstone and limestone conglomerates. Abundant petrified wood fossils are included. It is much variegated. The formation probably exceeds 800 feet in thickness.

The Shinarump conglomerate series shows only in a little patch north of the El Capitan and Chaistla butte region north of Kayenta. It is composed of gray conglomerates and sandstone, both of which inclose much fossil wood. The formation probably does not exceed fifty feet in thickness in this region.

THE BUTTES. In concluding the geological discussion, a few notes will be added on the buttes of the region, as they play an important part in the myths of the Indians of the present day, and undoubtedly did with the forgotten races.

The buttes about Tuba which are conspicuous are Tuba and Wild Cat. West of the road about half way between Tuba and Kayenta is Thief rock. Back of Kayenta are the Comb ridge buttons and points (which include Moqui rock and Lion Head rock), Slim rock, and the volcanic plugs of El

Capitan (Agathla or Wool Point of the Navajos), Chistla, Porras dikes, Black rock, Church rock, and an unnamed plug toward Chilchinbito, and many volcanic dikes.

The Comb ridge teeth (and buttons), Slim rock and Thief rock are residual bits of Navajo sandstone. Thief rock, the Saneneheck of the Navajos, was so named by the natives because near it is a pothole containing water from which animals which go to it to quench their thirst cannot get out on account of the slippery rock walls. It is 6,680 feet in elevation.

El Capitan has a basal diameter of 3,004 feet, placed upon a 200-foot elevated pedestal of Chinle sandstone and shale. Its elevation above the surrounding plain is computed to be 1,225 feet. It consists in the main of breccia agglomerate which is cut by branching dikes. The sedimentary blocks through which it protrudes are more or less metamorphosed or altered to quartzite and marble. As one looks at the peak from the south, it looks like a giant dunce cap, pointing to the heavens On the whole, it is the most conspicuous landmark in the whole region.

Chaistla (or Lazy butte), four miles south of El Capitan, also protrudes through the Chinle formation. Like the latter, it is composed of breccia to agglomerate of basal igneous fragments, shales, limestone and sandstone. It looks like a giant mitten with the back of the hand to the south and extended thumb projecting eastward. Its basal area is about 1,031 by 704 feet Its height exceeds 400 feet There are several other minor volcanic buttes in this same vicinity.

Black rock, about three miles east of the school, consists of two dikelike masses, composed of agglomerate and breccia, and of sandstone and minette of the augite-minette type The trend of the mass and dikes is N. 40° W. It protrudes through Navajo sandstone, which is much inclined on its eastern side, and is also much metamorphosed. In the northwest section the remains of a crater, in pot shape with broken north wall, can be clearly made out. The elevation of the main mass above the surrounding plain is over 300 feet

Porras dikes include various dikes and necks extending in a north-and-south direction for more than a mile. They are composed of breccia and agglomerate, intersected by dikes and sheets. The included materials are in all kinds of shapes, and include granite, sandstone and igneous rock blocks ranging from the size of pebbles to blocks weighing many tons. The group protrudes through Navajo sandstone (and Chinle rocks at the north terminus). In elevation they stand 300 feet above Comb ridge, which they top, or 700 feet above the floor of the adjoining valley. A spur dike leading out from this group also extends as a giant wall far to the southward south of Laguna creek.

The volcanic plug with its radiating dikes north of Chilchinbito much resembles Black rock, previously described. Its base is also of about the same area, but its height is considerably less. The formation through which it protrudes is McElmo.

Church rock is 300 feet in height, culminating in a pointed tower, suggesting its name. It has a large rectangular base with the longer axis running nearly north and south, from which a dike extends southward across the valley into the adjoining mesa to the southward. The butte is composed of included dikes surrounded by giant breccia or agglomerate of igneous fragments and sandstone blocks. It protrudes through Navajo sandstone and McElmo rocks. Standing in the valley of Laguna creek, it makes a picturesque landmark.

The lava which was hurled out by these craters and dikes has been wholly removed. Also probably 2,500 feet of the existing strata at the time of the upheaval have also been carried away by wind and water. Professor Gregory records that volcanic ash and other volcanic material are interstratified with the Tertiary that overlies the Mesaverde of the Moqui country and the south edges of Black mesa. In the Moqui region the volcanics overlie the Tertiary; elsewhere they are interbedded with the clastics. The edge of the Tertiary in which these volcanics are interbedded is yet undetermined.[3]

It is the writer's opinion that the included lavas in the Tertiary just to the south of the region mapped were hurled out, in part at least, by these volcanoes; or the volcanoes of this region were at least active at the same time. No remnant in the vicinity of the buttes is now capped with lava or has lava or ash interstratified with its rocks. It is therefore evident, it seems, that the original surface at the time of the eruptions has been wholly removed. This erosion has removed the Tertiary (?) wholly from the region, has reduced the Cretaceous to the limits of Black mesa, has removed the McElmo from the greater part of the area, and has made great inroads in the Navajo, Chinle and Shinarump rocks.

In 1903 the writer made a study of the lavas of the plateau region, coming to the following conclusion

"It is evident that eruptive activity has occurred in the plateau region from Cretaceous to recent time, and at least three well-defined epochs are at present recognizable and at least two distinct kinds of lava flows, viz

"1. The ancient volcanic necks and laccolites bordering the Rio Grande embayment and extending west across the plateau to Salt river and Gila valleys in Arizona, begun in later Cretaceous time, the lava sheets of which have been removed by erosion.

"2. The trachyte-rhyolyte lava flows of Tertiary times, which are mostly pre-Pliocene in age, and which are only partly removed by erosion.

"3 The basaltic flows and cinder cones, begun in Tertiary time and continued to the postglacial epoch, the last flows of which still maintain their original slope and extent."[4]

His conclusion concerning the Kayenta volcanic plugs is that they belong to the first-named group and were active at the time the region was being elevated above the Cretaceous sea, continuing their activity probably far into the Tertiary. To-day they stand as giant landmarks, indicating the colossal amount of erosion that has occurred since they ceased to be active.

SOIL.

The soil on the Segi mesas, Black mesa and northward from Comb ridge is thin with high porosity. The accumulated deposits in the valley often exceed fifty feet in depth, and are of a sandy constituent to adobe clay, with many grades between. Lime in composition is very small in amount, as there is but little lime in the adjacent country rock. Alkali patches are occasionally seen, but are not a prevailing feature. On the whole the valleys are fairly fertile when sufficient water can be obtained for the growth of plants.

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3 See Gregory, H E.; Geology of the Navajo country U. S. Geol. Surv Professional Paper 93, pp. 81, 82.

4. Reagan, Albert B.; Age of the lavas of the plateau region Am. Geologist, September, 1903, pp. 170-177.

CLIMATE.

The climate at Kayenta and Marsh pass is very similar to that of Tuba, except it is less warm in both winter and summer. The temperature ranges from 100 degrees in summer to —23 degrees in winter. The precipitation is also more than double that at Tuba.

IRRIGATION.

A government reclamation plant was begun in Laguna valley about four years ago. A dam was placed across Laguna creek at Moqui Rock, three miles above the school, and a ditch was constructed from it past the school. By this plant, 1,000 acres of land north and east of Kayenta, including 100 acres of school land, are to be irrigated. The project was completed last fall, the total expense exceeding $40,000. This is the only reclamation work in the region, except the few small dams and ditches of the Navajos by which an area of a few acres are irrigated here and there.

FAUNA.

Below is a list of some of the animals and birds found in the region, with notes on same:

DEER (*Odocoileus hemoinus*). A deer was killed by an Indian of Sam Chief't family just recently, and its horns are now to be found in the Buckbee-Vercamp trading store at Kayenta Formerly deer was very plentiful Many bones and horns of this species are to be found in the ruins throughout the entire region.

MOUNTAIN SHEEP (*Ovis canadensis*).

PRONGHORN ANTELOPE (*Antilocapra americana*).

The last two species are now extinct in the region at hand, though the antelope is seen now and then in the San Francisco mountain region Both were very numerous formerly, as their bones in the ruins attest They also have an important place in the pictographic writing left by the ancient dwellers, the mountain sheep being the most numerous

PRAIRIE DOG This animal is conspicuous and too numerous on all flats. The Navajos kill them, and removing the entrails, roast them, skin and all, in the ashes They are said then to have a good flavor. A prairie-dog bake is a great day among them Their principal mode of killing the animal is by drowning after a shower. The flood water is trenched to the hole, and when the animal emerges to escape the inpouring flood he is clubbed to death.

JACK RABBIT (*Lepus californicus texianus*). This animal is not numerous, but is still occasionally seen.

ARIZONA COTTONTAIL (*Sylvilagus auduboni warreni*). This animal is not plentiful at present, having been killed off by a plague a few years ago. It is a burrowing animal, and, like the prairie dog, is very hard to catch. Rugs and blankets were made from its fur in the old times, both by the Navajos and by the people of the cliff ruins and villages

COYOTE (*Canis estor*). Too plentiful.

WOLF (*Canis* sp.). Scarce.

KANGAROO RAT.

BLUE FOX. Reported to have been seen near Chinle. It is a variety

RED FOX.

GREY FOX.

WESTERN FOX (*Vulpes macrourus*).

KIT FOX (*Vulpes velox*).

WHITE WEASEL. Lives in prairie-dog holes, feeding on prairie dogs, mice, etc.

CIVIT CAT, or spotted skunk.

BADGER. It seems to be rare, though one is now and then killed. The hide of one is now being stretched in the Wetheril & Calville store.

PORCUPINE. This animal lives in the higher regions, feeding on the bark of trees and on pinion nuts.

LYNX. Not often seen.

COUGAR. This animal is reported to have been seen in the region.

PANTHER. Reported to have been seen in the mountain districts.

BOBCAT. Seems to be very numerous. The writer counted a dozen pelts of this beast in one of the trader's stores here to-day

BEAR (Navajo *shash*). They once lived in the lower regions of the country, but are now all gone, so the Indians report They now live in the mountain districts

GOPHER (*Thomomys* sp). Only a few animals of this family have been seen by the writer.

MOLE. Very rare

ALBERT'S SQUIRREL (*Sciurus alberti*).

TRADE RAT, or the Arizona bushy-tailed wood rat (*Neotoma cinera arizonæ*). This animal seems to be very plentiful.

NOTE —Bones of the jack rabbit, common rabbit and mountain sheep are plentiful in the refuse about the ruins Those of the pronghorn antelope and deer are also sparingly seen.

Of the reptiles the following are those most seen

LIZARDS. Several species

SPOTTED RATTLER Too numerous

DIAMOND-BACKED RATTLER. (*Crotalus adamanteus?*). This snake has been seen at the government hay fields between Chilchinbito and Kayenta several times

BULL SNAKE Probably several species

The birds of the region, so far as seen, are as follows

DADCHICK (*Podilymbus podiceps* Linn) Seen in migration

MALLARD (*Anas bochas* Linn) Seen in migration

BLUE-WINGED TEAL (*Querquedula discors* Linn) Seen in migration

GREENWINGED TEAL (*Nettion carolinensis* Gmel.). Common in migration

CANVASBACK (*Aythya vallisnera* Wils). Common in migration

WILD GOOSE (*Branta canadensis hutchensi*) Seen in migration.

LEAST BITTERN (*Ardetta exilis* Gmel) Probably a resident Quite common in the fall.

NOTE —All the ducks mentioned and the bittern were seen at different times at Summit lake (the "Cedars") and about the reclamation reservoir here during the fall of 1919

WHOOPING CRANE (*Grus americana* Linn). Common in migration.

SANDHILL CRANE (*Grus mexicana* Mull) Common in migration

COOT (*Fulica americana* Gmel). A very common bird, especially in migration.

JACKSNIPE Seen only occasionally.

GREATER YELLOWLEGS (*Tringa melanoleuca*).

KILDEER (*Ægialitis vocifera* Linn) Quite common in migration It was often seen about the lakes and pools of the region It is possibly also a resident

MOURNING DOVE (*Zenaidura macroura* Linn). A common resident It is quite abundant in the Segi canyons. The bird seems to be smaller, slightly at least, than the eastern dove.

RED-TAILED BUZZARD (*Buteo borealis*). Plentiful. A reed arrow plumed with the wing and tail feathers of this bird is used much in certain Navajo rites, especially in the "shooting deity" ceremony.

WESTERN RED-TAILED HAWK (*Buteo borealis calurus*). A very common bird. It lives principally on prairie dogs and rabbits. The writer has seen one hover over a rabbit burrow for hours waiting for the unsuspecting animal to come out to sun himself.

SWAINSON'S HAWK (*Buteo swainsoni*).

WESTERN SPARROW HAWK. Quite common.

CHICKEN HAWK (*Accipiter cooperi*). It is called *gini* by the Navajos. It is quite common.

EAGLE. This bird is called *asta dine* (the people who inhabit *Yaghahoka*, the heavens above) by the Navajos.

Western Great Horned Owl (*Bubo virginianus pallescens* Stone). The Navajo name for this bird is *spy*.

Burrowing Owl. Very common about prairie-dog towns. They undoubtedly feed on the prairie dogs.

Red-shafted Woodpecker (*Colaptus mexicanus*). A very common bird. The feathers of the radiating tail are used to decorate certain masks and medicine hats

Night Hawk (*Chordeiles virginianus* Gmel). Very common.

Clark's Jay, or crow (*picicorvus columbianus* Bon). Often seen about the yards at Kayenta.

Western Stellar Jay.

Pinyon Jay, or pine squawker. A very common resident.

Hummingbird. Seen at the head of Three-mile wash in June, 1919

Raven (*Corvus corax sinuatus*). A common resident

Crow (*Corvus brachyphynchus*, or *hesperis*, or *cryptolenca*)

Yellow-headed Blackbird (*Xanthocephalus xanthocephalus* Bonap) Common in migration. It was often seen in the fall about the Kayenta oasis

Red-winged Blackbird (*Agelaius phœniceus* Linn). Quite common in migration, probably being a resident in the higher regions.

Cowbird (*Molothrus ater* Bodd).

Meadow Lark (*Sturnella* sp.). Seen in the Segi canyons It was also observed singing on the government meadow between Kayenta and Chilchinbito, April 24, 1919

Bronzed Grackle (*Quiscalus quiscala æneus* Rigw) Only a few birds of this species were seen

English Sparrow (*Passar domesticus* Linn) Too numerous. They are a terrible pest at the school. Meat cannot be hung out in winter, as is the custom in this region, on account of these pests. They first eat out the tallow or other fats, and then the lean meat. They also eat up the young garden stuff and the repening grain

Junco species

Tree Sparrow

Lark Bunting (*Calamospiza melanrorys* Stejn) Seen in migration

Cliff Swallow (*Petrochelidon lunifrons* Say)

Wood Thrush.

Rock Wren

Nutcracker.

Robin (*Merula migratoria* Linn) Often seen, but it is not known that it is a resident. Several of them froze to death in the early blizzard that overtook the country November 26, 1919.

Western Bluebird.

Wild Turkey. This fowl is still occasionally seen in the higher regions. It was domesticated by the cliff dwellers Its feathers were woven into cloth and also used in the ceremonies.

FLORA.

The following plant zones are represented in the region. Little Colorado area, 3,500 to 5,000 feet elevation; zone of sage brush, 5,000 to 6,000 feet; zone of pine and pinyon, 6,000 to 7,000 feet; and the zone of yellow pine, 7,000 to 8,500. The plants so far identified by the writer are:

Horsetail (*Equisetum hiemale*).

Juniper (*Juniperus occidentalis*). At 6,000 to 7,000 feet elevation.

Juniper (*J. monosperma*). Same range as above

Red Cedar (*J. virginianus ?*).

Juniperus scorpulorum Sarg.

Juniper (*J. utahensis*). This species is commonly called cedar.

Oak Juniper (*J. pachyphlœa*). Reported in the region, but not seen by the writer.

PINYON (*Pinus edulus*). At 6,000 to 7,000 feet elevation.

PINYON (*P. monosperma*)?

PINE (*P. pondorosa*). At 7,000 to 8,500 feet elevation. It grows to 80 feet in height. The Indian Office estimates that 1,550,000 feet, b. m., of this pine are to be found on the Segi and Black mesas and about Navajo mountain, growing mainly in the upper reaches and in sharp canyons. The pine logs used in the reclamation dam at Moqui rock near Kayenta were obtained from the Segi.

DOUGLAS FIR (*Pseudotsuga mucronata* [Raf] Sudw) This species occurs in small groves. It is more abundant near Fort Defiance.

SPRUCE (*Pseudotsuga taxifolia*). This species is scattered here and there in the high canyons, 7,000 to 8,000 feet in elevation. It is used in the Navajo ceremonies and in certain of their rites.

ENGLEMANN SPRUCE (*Picea engelmanni* Parry). At 7,000 to 8,500 feet elevation. The Indian Office estimates that there are 12,000,000 feet, b m , of this species in the Navajo country. This species is principally seen in the region east of the country covered by our map, principally on the Fort Defiance plateau, etc. It grows in small groves.

MOUNTAIN MAHOGANY (*Cercocarpus parvifolius* Nutt.). Sticks of this species are used in the "night chant" of the Navajos, and are also found in the ruins of the region.

CHERRY. The cherry bark and also the wood are used in the "night chant" ceremonies.

Forestiera neo-mexicana. This species is used in the "night chant "

COTTONWOOD. Several species are represented in the region, among which are *Populus monolifera, P. wislizenus, P. acuminata*. They are found at altitudes ranging from 7,000 to 8,000 feet.

QUAKING ASPEN (*Populus tremuloides*). At 6,500 to 8,500 feet altitude There is quite a grove at the head of Three Mile wash, and several groves in the Segi mesa region.

OAK (*Quercus gambellii*). This species is found in close-set groves in moist places at all elevations A large patch heads Three mile wash. A large patch is also to be found both at Betatakin and Keetseel ruins in the Segi region A large grove used to also occupy the site of Kayenta. The groves are mostly on the north slopes of the mountains and mesas.

BOX ELDER. This tree is found growing in protected, moist places, usually along the north walls of canyons or mesas A clump is to be found on Laguna creek about five miles below Kayenta The front of cliff cave 96 is studded with box-elder trees. Several clumps were also seen in the Segi region, and two in the Three Mile wash section

WILLOW (*Chilopsis linearis*). Baskets from this plant were made by the ancients

DWARF CHOKE CHERRY. This shrub was seen in the vicinity of Keetseel.

WILD CURRANTS. Two species These were seen near Keetseel. They were found in the canyon.

GOOSEBERRIES. These were also seen near Keetseel.

CLIFF ROSE (*Cowania mexicana*). Indian name, *awetsal*. A pipe and stem is made from this plant. The pipe is painted yellow and is used in some of the Navajo ceremonies.

AROMATIC SUMAC (*Rhus aromatica*, var. *trilobata*). Rather rare. Baskets are made from the twigs of this plant.

COMMON REED (*Phragonites communis*). This plant is used in making flutes and whistles. It is also used in making the ceremonial cigarette of the Navajo. The reed is cut off between the joints (nodes) with a sharp, white stone. It is then rubbed with sandstone, after which it is painted. A wad of feathers is then put in it to hold the tobacco in the hollow. It is then filled with tobacco and smoked, the smoker puffing a puff of the smoke in turn toward each of the cardinal points, beginning at the east. This act is a prayer.

NATIVE TOBACCO (*Nicotiana attenuata*, and *N. palmeri*). Rare. It is much used in the rites, and was so used by the cliff people, as their pipes indicate.

RABBIT BRUSH.

SAGE BRUSH (*Artemisia*). At 5,000 to 6,000 feet elevation

GREASE WOOD (*Sarcobabus*). Same elevation as above.

WILD FLAX. Found in the lower levels.

Sporobotus cryptoandrus. The seeds of this plant are ground and used in certain ceremonies.

YUCCA. The yuccas are quite abundant. The principal species seen are: *Yucca baccata* Torr. *Y. angustifolia*, *Y. glauca* Nuttall, *Y. radiosa* Trelease, and *Y. elata* Engl. The first two are the ones most usually seen, though the second is the most abundant. Masks are made from the leaves of the *Y. baccata* (Spanish bayonet), the masks being used in the "night chant of the Navajos. The plant is called *hashkan* by them. It is the coarser of the yuccas represented. Drumsticks are also made from its leaves. Its fruit is edible. It is known to the natives as "banana yucca," on account of the bananalike resemblance of its fruit. The fruit is roasted in the ashes by the Indians, much as potatoes are roasted, it then having a fruity flavor to a slightly burned-squash taste A dinner of yucca fruit is a feast for any Navajo. Both the plant and fruit are used in the magic ceremonies of the fire dance. All the yuccas are used in the Navajo rites Counters in their games are also made from the leaves of *Y. glauca* The roots of all the yuccas have soapy properties and are used for washing purposes. All have fibrous leaves, which are used by the natives for cordage Among the cliff dwellers of the region this fiber was used for making thread, ropes, matting and cloth. The Kayenta ruins have yielded much fabric made from this material

CACTUS. The cactus family is represented in the region, but is not as plentiful as farther south. The principal species so far seen are cane cactus (*Opuntia arborescens* Englm), round cactus (*Mammilaria* sp), a flat-leafed cactus, or prickly pear, and the sitting cactus (*Cereus phœniceus*). The cane and flat-leafed varieties seem to be the most numerous

SCATTERED BONE MEDICINE (*Arabis holbollii* Horneman). Indian name, *azeladiltehe.* It does not grow in heads or clusters, but usually singly

Cutierrezia enthamiæ. This is a weed under which the Navajo place their sacrifices in the "shooting diety" ceremonies It has a yellow, composite flower Its Indian name is *tsildilgisi*, or "hiding weed"

Verbesina enceliоides Indian name, *indigili niltsoni*, or "strong-smelling flower" A cigarette is made from this plant It is painted white When finished it is placed over the door of the hogan in certain ceremonies.

TUMBLEWEED (*Amorantus albus*) Indian name, *tlotahi nagisi* The seed of this plant and allied species used to constitute an important diet of the Navajo, and is still more or less used It has also been found in jars in the cliff houses.

MARIPOSA LILY. This is a very prominent and beautiful flower on the sand-covered benches between Tuba and Red lake in June each year.

SEGO LILY This plant grows profusely throughout the region

FIREWEED This plant is not common, but is occasionally seen

MUSTARD. This family is fairly well represented

WILD HOPS. Several vines of this plant were seen near Keetseel.

WILD CURRANTS. Two species These are very plentiful about Keetseel Wagonloads of the fruit could be picked annually, but it seem that no one cares enough for them to pick them. The fruit is sweeter than the eastern currant.

RAGWEED. This plant was seen in the vicinity of Keetseel.

DESERT PRIMROSE (*Lavauxia primiveris*). This plant is very common

SNOWBERRY. This plant was seen in the vicinity of Keetseel.

ARIZONA DANDELION (*Malacothrix glabrata*). This plant is often seen

INDIAN PAINT BRUSH (*Orthocarpus purpurascens*). This plant is seen now and then on the north slopes.

OWL'S CLOVER (*O. purpureoalbus*) is occasionally met with.

PLANTAIN (*Plantago* sp.). Several plantain plants grew in the school yard in 1919.

PIGWEED, or desert lamb's-quarter (*Chenopodium incanum*) It covers the flats in summer and makes much pasture for the sheep.

RUSSIAN THISTLE. This plant is a recent comer to the region. It is prolific and is driving out many of the native plants. It makes good pasture for stock, especially sheep, when young and tender, but as it ages it gets spiny and hard. It is said to make fairly good hay when cut at the right time.

Mallow. Several plants of the mallow family (*Sphæralcea* sp.) grow here, one very small, one very tall.

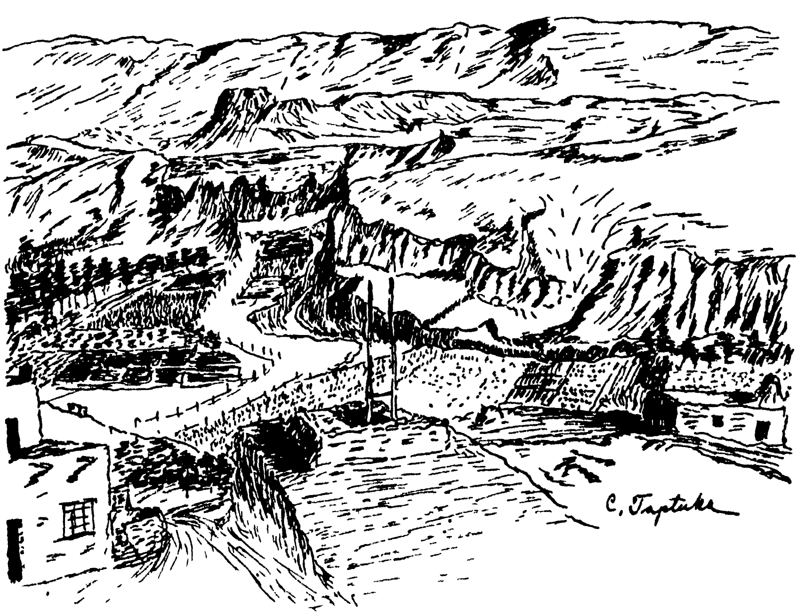
Purslane. Several species of the purslane (Portulaceæ) family are seen now and then, also the carpet weed.

Jimpson Weed (*Datura meteloides*). The flowers of this plant are very long. Their color is white, tinged with lilac on the outside. In the hotter parts of the day they droop like wet tissue paper. The leaves of the plant are very large. The Navajo medicine men use the juice of this plant and the flower as medicine. It has effects similar to the payote bean, reacting on the patient much like the "hasheesh" does on the dervishes of the East. It also makes the pulse run high and a delirious stage is very often reached. During the "flu" epidemic it was much used by the medicine men as a remedy. One patient who had been treated by a medicine man with this "medicine" was found by the agency physician, Doctor Reynolds, to have a pulse running as high as 240. She recovered and is still living. When under the influence of this drug the natives also often reach the stage of perfect frenzy, at which times they shout, gesticulate, dance and prophesy

In closing his remarks on the flora and fauna of the region the writer wishes to add that most of the animals, birds and plants mentioned above are represented by fragments in the debris of the cliff houses and village ruins of the region, or by pictographs of that race found chiseled along the canyon walls.

HUMAN HABITATION.

When the white man came to the region he found the Navajo in possession, as he is to-day; but before the coming of the Navajo another race made it their abode for a very long period of time. This race was the cliff- and village-house people. Their ruins dot the country. Below is a description of same in the order as examined by the writer.



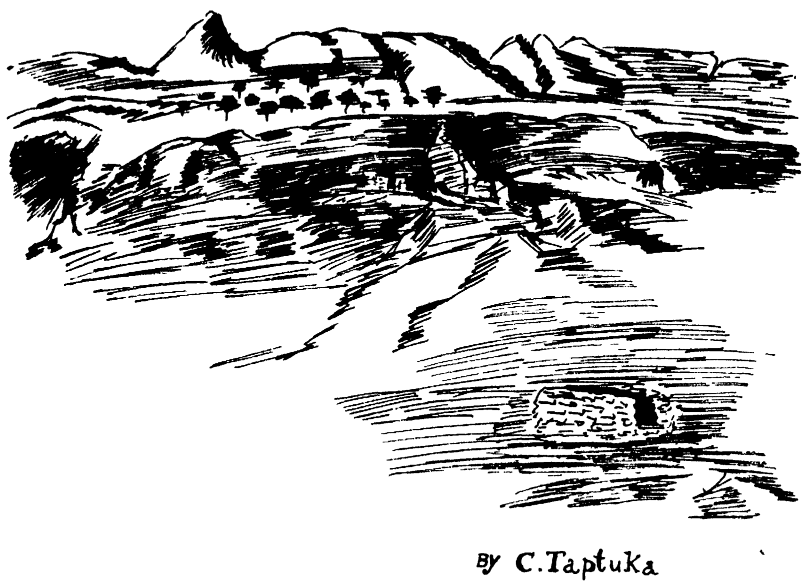
Moenkopi canyon, looking east from the Kiva at the Indian village of Moenkopi. It shows the country over which Farfan, Ovate and Espejo traveled in coming to Moenkopi from Oraibi and Awatobi.

Ruins from Tuba to Marsh Pass.

Many ruins dot the valley between the entering of the Tokas Jay wash below Red lake and Marsh pass, but time would not permit the examining of most of them. Those visited are here given.

Some years ago some one started a trader's store up against a mesa on the west side of the Tokas Jay some miles south of the present Red lake trading post. The walls of the abandoned store still watch over the site. Some distance above (north) this store on an adobe flat, which is now trenched by washes, are parts of walls of an ancient village. Much pottery shards dot the site. From general appearance the village was rather large.

There are prehistoric burials about Red lake. Traders there told the writer that many skeletons and much beautiful pottery had been found in that vicinity. The country there is a sand-dune region and the former burials are



A cave-cliff house northwest of Kayenta.

uncovered by the wind. The writer saw much of the recovered pottery, but his short research period there failed to disclose the village or villages which are undoubtedly there and from which the burials were made.

In the vicinity of Cow springs there are several ruins. On a sand ridge over which the road crosses, about a mile east of the springs, there are the remains of a large ruin now leveled, and represented only by grinding slabs and the broken pottery which cover the whole hillside. Judging from the abundance of the broken pieces, at least 500 people must have occupied the village. Leaving these springs, village mounds were then passed one after another. One of the ruins, situated westward from the road on a promontory on the edge of the plateau, still has high walls standing. Another small ruin was passed near the road about half way between Cow springs and the sand hills. It appeared to be the remains of a small pueblo. Another lies about a quarter of a mile west of the road, across a mud flat that becomes a shallow lake in the rainy

season. This ruin centers about a rocky hill, which has a basin area to the northward and to the northwest as well as to the east, a wash entering these flats from the west-northwest. On the rock knoll are rock walls of former houses still standing. They were built in rectangular form in a north-south direction. The ground plan of quite a number of rooms can be made out. About this knoll in the flat above the water line, especially to the eastward of the knoll, there is evidence that there was once a very large adobe village, now wholly leveled. Metates and manos and a large quantity of broken pottery now mark the site. It is easy to assume that the stone-walled structure on the knoll was the citadel of the place, around which was clustered an extensive village built of less durable material. The inhabitants of this village depended on this shallow pool and its accompanying wash for their village water supply and for irrigating their crops on adjacent fields. More extended investigation than the writer had time to make will probably disclose check dams and reservoir dams on the wash mentioned, placed to inclose a permanent water supply, as in many cases which will be cited later. If the water could be impounded that descends from the mesas to the northwestward through this wash, and the same held for use as needed, a large village and a considerable area of land could no doubt be irrigated and furnished water as needed. In August, 1919, the writer, in company with Mr. C. Calville, came from Tuba to Marsh pass in an auto. Clouds hung off to the northwestward over the mesas, but it had not rained in the valley. Coming to this flat, in the outwash area from this wash, we found the water four feet deep, a mile wide and four or five miles in length, with a rapid current flowing toward the south. As a result they had to go to the hills to the eastward to get around this flood. Could this water have been impounded, as the village people no doubt impounded it, it would have lasted a long time for village use and necessary irrigation. It is also quite likely that those ancient people's fields were in the flats mentioned, which, that the check dams and reservoirs are obliterated, are now flooded after every rain.

The Marsh Pass Ruins.

The next ruin seen was in the vicinity of Cedar ridge. From this to ruin A, near Marsh pass, twenty-six ruins were observed. They were situated mostly along the northeastern side of the valley, along the rock slopes toward Black mesa, on the first rises of land toward that mesa, or on hummocks of sandstone at the east edge of the valley. Some also were perched on adobe flats, some on bare rock. They were all observed to be much tumbled down, usually piles of building stone, with a wall occasionally projecting. About these sites and on the slopes and in the valleys below them are great quantities of broken pottery. The writer was also advised by Indian Agent Walter Runke that the canyon leading to the former Marsh pass coal mine in this valley contained many similar ruins to those found in the valley.

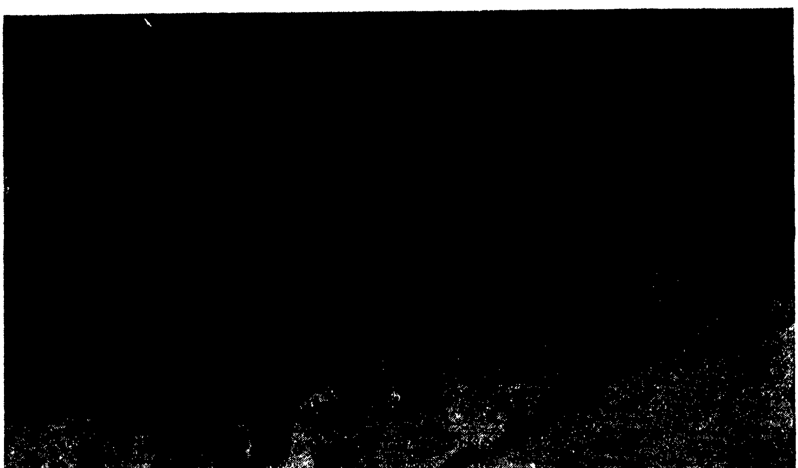
Ruin A. This is "ruin A" of Fewkes,[5] Cummings,[6] and Kidder and Guernsey.[7] The ruin stands on the west edge of a promontory northwest of the

5. Doctor Fewkes; Navajo national monument paper: Bull. 50, Bureau of American Ethnology, Washington (1911), p. 10.

6. Cummings (1910), pp. 28, 29.

7. Kidder and Guernsey; Archæological explorations in northeastern Arizona. Bull. 65, Bureau of American Ethnology, Washington (1919), pp. 61, 62.

road, and can be seen for miles. It consists of a long building, extending approximately in a north-south direction. It is 30 steps long by 10½ feet wide, with a heavier low wall extending from it both at the north and south termini, as is shown in the plate. Part of the north end and all of the south end have fallen out and the two parallel walls have been broken through. The building was evidently once two stories high. Some cedar poles of the second-story floor are still in place. The rock of the walls was well laid in adobe mortar. The outer surfaces were polished, apparently having been polished after the wall was laid. There are slight evidences that the inside of the wall was plastered with adobe. Some "sculpture" work on the rocks of the walls was also incised. About this ruin there are but few pottery fragments, and, from appearance, it was never occupied as a dwelling. Remains of at least three large villages are on the east and south slopes of the same



Betatakin

promontory on which this ruin is situated, all within 600 yards of it. From all appearance the writer must agree with Doctor Cummings that the standing building probably represents the "fort" or citadel of these adjacent villages. For further reference to this ruin the reader is referred to the references in the footnote above.

Ruin B. This is "ruin B" of Fewkes[8] and "ruin 8" of Kidder and Guernsey.[9] It is in a cave high up on the rock wall of the mesa to the left of the road as one approaches Marsh pass from the south. It stands bold to view over a bench across a gulch, and it, with its inclosing cave, reminds one much of a giant, distorted mouth with broken teeth (the crumbling house walls) projecting upward in an irregular line from the lower jaw. The ruin was undoubtedly built there for defense on account of its protecting rock walls and its almost inaccessible approach. It seems to have been built after the "tower house," which stands on a spur just below it (ruin B), as fragmentary rock

8. Fewkes; loc. cit., pp. 10-12.
9. Kidder and Guernsey; loc. cit., pp. 56-61.

like the polished glyph-cut rocks of that ruin are incorporated in its own roughly built walls. The remains of twelve rooms, a tower and two kivas still show.

Below ruin B, on the floor of the creek that enters Segi canyon from the south, under a rock ledge of the adjacent mesa to the left of the road, are fragments of walls of a once small village. It is in plain view from the road, and while inconspicuous in comparison with the other ruins of the region, it shows how the peoples of that distant time utilized every possible place of protection the region could afford.

Ruin C. Just below the mouth of Segi canyon, adjacent to the rock walls of the mesa west of Laguna canyon (creek), are low mounds of what appears to have been a large village in the open. The site is marked by building stone and broken pottery. Opposite it, in a small recess under a large outstanding rock, is what was probably a granary. The recess is walled up across its front, with a small doorway about 18 by 20 inches still intact.

Ruin D. As the road descends Marsh pass to the flats to the northward it passes over a small ruin, now mostly represented by broken fragments of pottery. It is not likely that more than fifty people ever lived in this village.

In the pass between ruin A and ruin C there are fifteen ruins, all of small size. In Kinboko canyon, that ascends southwestward from ruin A, there are three caves which seem to have been the burial places of the basket-maker village people, likely the first villagers who came to the region. And along the comb and in caves in it north of ruin C in the first four miles there are five other ruins, one of them being the famous "Sunflower cave," from which twenty-five wooden "sunflowers," two buckskin sunflowers, a carved wooden bird, and twenty-five varnished, cone-shaped objects were obtained. All these ruins have been described or more or less mentioned by Kidder and Guernsey to whose work the reader is referred.[1]

The Ruins in Segi Canyon.

The ruins in the Segi canyons and Segihatsosi exceed twenty-six in number. Outside of Cliff Palace, two of these ruins, Betatakin and Keetseel, are two of the largest cliff ruins in the United States. They seem for the most part to have been discovered by the Wetherils, who also discovered the Mesa Verde ruins. Richard Wetheril visited Keetseel as early as 1894 and 1895, and Betatakin was discovered by John Wetheril in 1909.

Keetseel and adjacent ruins. Keetseel is at the head of what is known as Middle canyon of the Segi group of canyons, some seventeen miles up the canyon from Marsh pass. Above it the canyon becomes boxed. The ruin is well preserved. The rooms, including the circular kivas and rectangular kihus, probably exceed 150 in number. The length of the village is about 300 feet. It is picturesquely perched upon a bench under an overarching cliff of Navajo sandstone, which completely overtops it, though there is evidence that village rooms in the flat abutted this bench, some rooms of which still remain in a fairly good state of preservation. The ruins also continue on southward from the ledge over 100 yards to the end of the curving wall that hoods in and backs the main ruin. A huge log, thirty-five feet in length, extends across an open space in the building plan, and probably once supported

1. Loc. cit., pp. 61-97.

a retaining wall, which has since slid down the sloping bench, leaving the log over the gap. Another noticeable feature was that the walls of many of the rooms were found to be formed by twigs, limbs or poles being placed in upright position, over which adobe mud had been plastered. Other walls were made by rows of sticks interwoven with twigs, over which adobe plaster was daubed. Such walls are also found at Betatakin. The burned ruins in the Pine-river region showed that their walls had been made in this manner, but these are the first walls of that type seen by the writer. Another thing about these ruins that the writer wishes to mention is that at the base of the detritis in the canyon adjacent to this ruin are imbedded pottery and village implements, which shows that there was a ruin in the vicinity before the valley fillings were placed there by water and wind. This village, stipulated so as to face the morning sun, must be seen to appreciate the impressive vastness of itself and its overtowering arch.[2]

Keetseel.

About Keetseel are clustered quite a group of ruins, probably ten within a radius of five miles. Those visited by the writer are as follows:

Ruin E *(Turkey House)*. This ruin is one-fourth mile around a rock corner north of Keetseel, in a *rincon* corner on the same side of the canyon. Mr. Cummings' party excavated a part of it in 1911, so a notation on the wall of the canyon states. Thirteen rooms and parts of two estufas show. The walls of the north estufa (kiva) still stands five feet high. A corn-grinding mortar box with metate is in place, as is also an inclosed fireplace with ashes in it. Its diameter is about fourteen feet. The south kiva has a front-fire chimney (ventilator), and a fireplace, north of which is a small, rectangular inclosed space one foot long by eight inches wide, inclosed in four rock slabs. Two posts that helped support the roof are still in position, though their tops have been removed. This kiva also has a metate box with metate in place,

2. See Fewkes, loc. cit., pp. 16, 17, for a further description of this ruin.

and a chink in the wall to place the metate when not in use. It is also a six-pilastered kiva. The village was very extensive.

Ruin F. Just above an east entering wash across the canyon from ruin E is a small cavelike room space against the west face of the canyon walls. A ruin occupies the site. Part of one room remains standing.

Ruin G. On the east side of a rock point north of the creek, about one-half mile east of the Keetseel creek junction with Laguna creek (Segi canyon), there is a cliff ruin about 140 yards in length, running along a shaly, nodually ledge between massive ledges of sandstone. The rooms were excavated wholly or in part. Part of the walls of two rooms and one whole room still remain. The depths of the rooms were from five to seven feet; height, less than five feet. The door seen was less than two and one-half feet by two feet.

Ruin H. About 300 yards north of ruin G, on an east-and-west-running cliff extending eastward from the cliff along which the latter is located, there is a small cliff ruin in a naturally worn ledge under a sandrock cap roof. The ruin

Wickerwork adobe-plastered walls, Keetseel.

seems to be composed of three rooms. It is high and at present inaccessible, as the approach to it is worn away. On a long, sloping surface leading toward it from the south are the pounded-in footholds on which that happy people clambered in the long ago.

Ruin I. East of the next point north of the creek, east of ruin H, there are indications of a ruin on a little knoll. Some pottery, metates, etc., show; also a fireplace box and part of a wall.

Ruin J. About a half mile east of ruin I there are the remains of two very small ruins in the open, one on each side of a south-flowing arroyo.

Ruin K. South of a bluff north of the Segi (Laguna) creek, at the falls, is a single room dug into a soft streak in the ledge. Only a part of the walls show. The ruins here were probably more extensive, but have been removed by time.

Ruin 8—The Swallow Nest Group. Possibly five places where rooms could be built up high just under the cap rock, two of which now have rooms, show from the trail. Swallow's nest is the largest and most conspicuous. It fills the bottom of a vaulted, symmetrically formed, open cave. Seven rooms are more or less intact, some more than one story high. The ruin was found to be in a poor state of preservation. It is the first cliff dwelling as one ascends the canyon from Marsh pass.

The other large ruin in the Segis, as noted, is Betatakin, or "High Ledges House." It is situated in a canyon that leads off to the left from the main Segi (Laguna creek) canyon about five miles above Marsh pass. The ruin is about two miles up this side canyon. It is situated on a bench under a great arch facing the morning sun, as was Keetseel. It was 600 feet in length and was probably originally a much larger village than Keetseel, but has suffered more by the ravages of time. More than 100 rooms are probably now visible. At least two of these are ceremonial rooms, but, differing from the Keetseel kivas, they are rectangular in shape; no circular kivas were seen. Eylets were also seen cut in the side of the cliff, problematically for the placing of beams in house construction. This ruin also differs from Keetseel by its having a "gallery"—a group of rooms upon a shelf much above the main ruin, to which access could only be had by a long pole ladder. This was probably the citadel of the village. A dripping spring is situated near the ruin and probably furnished the water for village use in that far-off time. The walls of the village have been partly restored and strengthened by the government. On the canyon walls adjacent to the southeast are drawings of a shield and a mountain sheep. In approaching this village, as with Keetseel, one is struck with awe, some with a sort of terror, at its stupenduous impressiveness.[3]

As a closing remark on the Segi ruins it might be added that in the long ago, as mentioned in another section of this article, the canyons were deeply cut. Then there was an aggrading of the canyon floors till the deposits often exceeded 50 feet in thickness, and this aggrading was still going on less than 40 years ago, the region being then a ponded, laked region. Now the streams have again cut to bedrock in the valley fillings. In the times of the villages there was undoubtedly plenty of water for irrigating purposes, and there is still. There was also a wide valley floor on which crops could be raised, and still can. There is enough land in the Segi canyons to support a population of 2,000 Hopi Indians, even as Hopis live to-day.[4]

Kayenta Ruins.

Ruins at Black rock. Black rock is a black volcanic rock point situated about three miles a little north of east of the Marsh Pass school. No ruins were built against the perpendicular walls of this rock, the walls exceeding 300 feet in height, the cliff people, no doubt, being afraid of falling rocks. But there are two sites of ruins in the vicinity, one in the flat to the west of it and one on the southeast slope of the south expanding part of the rock itself. Both of these villages were built of basaltic rock, plastered in with adobe mud.

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3. See Fewkes, loc cit, pp. 12-16. Also James, George Whorton; Arizona the Wonderland, pp. 58-60, for descriptions of this remarkable ruin.

4. For a more complete account of the ruins of the Segi canyons the reader is referred to Doctor Fewkes' work, cited above

The ruin on the southeast slope of the rock was quite large, as the heaps of rocks now show. Some foundation walls are still in place, but the buildings are all leveled. Probably 150 people lived in the place at one time. The site is much frequented by arrowhead hunters, more arrowheads being found there than about any other village ruin in the region.

The ruin in the flat west of the rock, coming within fifty feet of it, is now also leveled by the action of time. Besides the main ruin there were several detached buildings. Part of a circular room shows in foundation, probably a kiva. A large mound also shows, which is evidently the remains of a *mal pais* (basaltic rock) erected building. This ruin covers a space 400 yards long by probably 100 yards wide, its longer dimensions being in a north-and-south direction, but does not show a compact form of village, as is the usual style of that far-off time. Probably 100 people lived in this village. Much broken pottery and many metates and manos have been found on the site; also the writer found in the kiva debris the finest specimen of an Indian axe he has yet seen.

No. 10. (Nos 1 to 9 are the ruins at Tuba, formerly described.) This ruin is on what is known as Moqui rock, an irregularly shaped sandrock butte just north of Laguna (Kayenta) creek, just west of the dam and reservoir system of the United States reclamation system, three miles west of Kayenta post office and the Marsh Pass Indian school On it are the remains of a considerable ruin that was built, at least in part, of stone. On top of the butte are the remains of stone walls; also a sinus in the rock face, sloping southwestward, exhibits the remains of a wall crossing it; and southeast of the butte, in the flat, there was once a large village. Though bare of everything but scattered rocks and occasional foundation-rock walls, the top of the butte is still covered with pottery shards, notwithstanding the ever sweep of the southwest winds, which have removed the last vestige of the mortar and adobe that contributed to the make-up of the walls of the village of this long-forgotten people. The area of the top of this rock available for building purposes is between one-eighth and one-fourth acres, and the plan of the village, now extant, shows that every bit of it was utilized. The site was superb.. On the east and north the walls of the rock are seventy-five feet in vertical height and are almost perpendicular. The other face of the butte slopes southeast to the very water of Laguna creek and to the flats which then occupied the space where Laguna creek now runs. This made the rock easy of access from this side, but the village, from the lines of walls still in extant, shows that it was protected on this side by strong walls. For protection, therefore, the village was well located; also located handy to water and close to adjacent valley lands that were suitable for irrigation farming. When Laguna creek did not exist there were lakes in the vicinity, also the giant spring which now forms the hole in Laguna creek 500 yards below Moqui rock, now known as Kayenta (Tyende). From the size of the village on the rock and the site adjacent in the valley, between 500 and 1,000 people must have lived here at one time. In addition, the arrangement of the villages about this rock in the adjacent flats (see plate 4) indicate that it was the citadel or fort of the community, to which the villagers in the vicinity could rush when attacked by the more savage hordes. Within a radius

of three miles of this rock there are the remains of fifty-nine known villages. This bears out the conclusion that this rock, as a hub, was the central fort of this section.

No. 11. In the valley of Laguna creek about due north of the boarding school, in a little flat between the rock walls to the southward and the creek, there is quite an area covered with pottery shards and occasional ridges of what probably was once adobe walls or house foundation outlines. Some walls show in foundation. The village was large, and probably had 500 inhabitants. In appearance it looks like it might have been as large as the present village of Jamez, N. Mex. It occupied a good site, though exposed in the open. The people who lived there were not afraid of enemies or they would not have built such an exposed village, unless they fled to Moqui rock or village No. 21 when attacked. Up to thirty-five years ago Laguna creek did not exist, as we have seen, and had not for many ages; also it had not occupied its present valley north of Comb ridge north of Kayenta for a longer period, as the adobe fill is seventy-five feet thick throughout this region. In the long ago when this village flourished the valley was no doubt flat floored and streamless At that time a lagoon was formed southwest of the village between it and the V-shaped walls of Comb ridge adjacent, the village probably helping itself as a dam in impounding the water. This ponded area also extended eastward south of the village for quite a distance, and is a collecting basin for water even in our own time. Farm land was also found in the flat valley adjacent.

No. 12. An ancient ruin once occupied the top of a promotory capping the sandrock ridge between the school and Laguna creek, though every particle of the village and its pottery has been removed by the contending elements. The evidence that the village once occupied the site is that pottery shards surround the point in the talus debris on all sides. Possibly the village extended to the base of the promontory also. There are no criteria to indicate the size of this village. The site is fairly well suited for protection from enemies.

No. 13. Pottery fragments of a small village were found in the open flat about one and one-fourth miles southwest of Porras dikes, about one-fourth mile north of Laguna creek. The pottery covers a circular area. Unless much of it has been removed by wind and water, it was a very small village, containing less than 100 souls. No trace of walls could be found, only the mound and the shards. It was wholly unprotected from an enemy. No doubt they farmed the adjacent flats. The writer found Navajos planting corn in the mouth of a dry wash near there this last year. Their water supply was furnished by springs in the adjacent Navajo sandstone bluffs about a half a mile distant to the northward. There is a fine dripping spring there now.

No. 14. This is a ruin on the top of a flat, rocky promontory one-half mile northeast of ruin 10 (Moqui rock). A gulch and Laguna creek separates the two ruins. No walls remain; only broken pottery marks the site. It was close to Laguna creek and also to the flats east of the rock-bound mesa on which it is situated. A rock promontory abutted the village at the northwest, on which there was probably a watchtower. The village was fairly well located for defense. Its size cannot now be determined.

No. 15a. This village topped a gentle ridge just west of the flat through which Three Mile wash runs, about a mile south of Moqui rock. The ruin is 300 yards long from east to west and of good width, though the original width could not be determined in the time the writer had to examine it, as it would require considerable digging to determine the limits of the village. Judging from the adobe heaps and the pottery fragments, the village must have surrounded a plaza with an opening to the east. Also, east of what one would naturally suppose to be the eastern limit of the village, judging from the earth piles, there appears to be the remains of a graveyard. The pottery found here seems to be less broken and never to have been used over a fire. The village seems to have been about as big as the present village of Jamez, N. Mex., and probably contained 400 inhabitants at its flourishing time. Situated on the slight rise above the common flat, it certainly was not located in such a site for defense. Otherwise it was admirably located. Three Mile wash in its lower, incised course did not exist thirty years ago. Up to that time the water of the wash gathered in what was termed a pool in the flat about east of the site of this ruin, and no doubt did the same in the long ago. This furnished both water for village use and for irrigating purposes. Something like 500 acres adjacent could then have been irrigated.

No. 15b. This ruin is about one-fourth mile east of north from ruin 15*a*. Its exact size and shape could not be determined, as it is partly covered with dune sand. Judging from its broken pottery, it was as large as ruin 15a. It was defenseless, but like its sister village, there was an abundance of water, also a large agricultural area adjacent to it.

No. 15c. (See plate 4 for plan of this village.) This village is situated on a rocky promontory about one-fourth mile northwest of ruin 15b and about due north of 15a. Its foundation walls were of rock. The main village was in rectangular form, 100 feet in length by 35 feet in width, extending in an east-and-west direction. It was divided into two sections, both extending in an east-and-west direction. The north section was 10 feet wide and was composed of rooms. The south section was 25 feet wide and seems to have been a plaza, probably surrounded by rooms. It is considerably lower in the center than on the margins. East of this main ruin, and probably forming a part of it, are the remains of a triangular set of ruins, in the center of which is a circular depression, which was most likely a kiva. The whole ruin covers the entire top of the promontory, and owes its shape to the contour of same. The promontory is 25 feet high and was evidently chosen for a village site for defense. Its village was probably the watchtower village for 15a and 15b and village 62, which will be described later. Its foundation was of stone, as indicated. The rest was evidently of adobe, which has been removed by the winds, as there is no stone left in the room space. The cross walls also seem to have been of adobe, as no trace of them is left. East of the rectangular structure is a rather large sink, which is probably the site of a kiva, as previously noted.

No. 16. Just around a point of a cliff across an arroyo one-half mile southwest of Porras dikes there is an arched-over cavern cliff from which a spring issues. Just east of the spring the huge Navajo sandstone cliff has broken off in giant blocks, which have simply fallen so as to remain as perpendicular monolithic blocks in front of the cliff's face. The place when these great

blocks still formed a part of the cliff would have made an excellent location for a cliff house or a cliff palace. We dug at the base of the fallen blocks to see if we could find any trace of such ruins. Our labors favored us, for we found ashes, charcoal, calcined rocks, and an Indian axe. Though this was not conclusive evidence that a cave ruin occupied the site, the writer is led to believe that such did, and that the caving off of the giant blocks likely drove the inhabitants from their secluded home. Certainly before the cleaving of the rock face it was an ideal place for a cliff house.

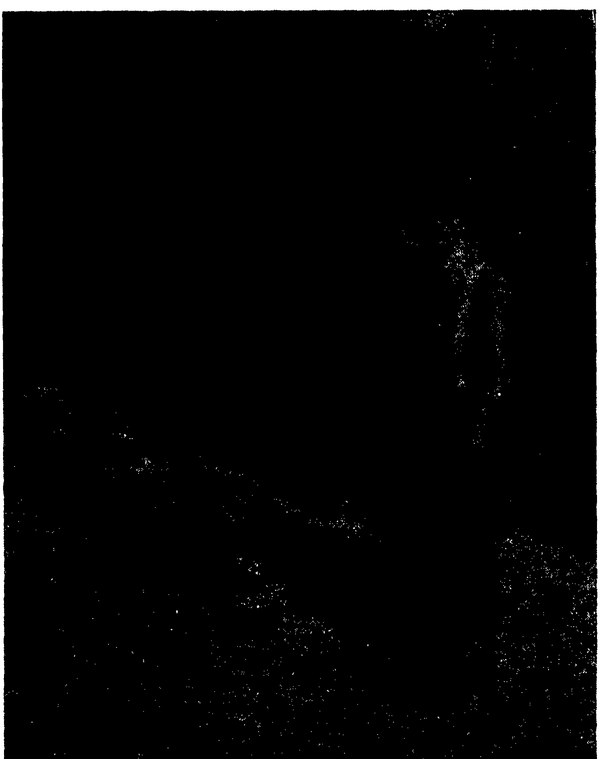
No. 17. Taking the road from Kayenta to Ship rock, past Church rock to within two miles of the eastern boundary of the Western Navajo reservation, one comes to a stone house by a spring which emerges from the north wall of the mesa that faces Tyende (Laguna) valley here. Also near the house to the southwestward there are two wells. The house has the honor of having been built and completed by a Navajo, the only house, so far as the writer can learn, that a Navajo ever built to completion for his own use in the Navajo country proper. It also has the honor of having its mistress buried in it. When the "flu" struck the place the lady of the house died just north of the rather pretentious fireplace, and the simple aborigines, being afraid of the dead, refused to touch her dead body, but instead they carried dirt and heaped it up over the body where she lay. They then broke the shovel and fled in such haste that they failed to shut the door to the house. Eleven days later, when the writer arrived on the scene, they begged him to shut the door, as "white man no fraid of chindes" (devils, or dead spirits). So he shut the door and fastened it for them. But as to the ruin the writer intended to describe· Near this springy place there was once a large village, only pottery shards now marking the spot. The writer also found a stone axe there. The place was well chosen. The springs furnished plenty of water, and to the northward adjacent there were rich farm lands, now too dry for farming for the most part, on account of Tyende creek having recut its channel so that the drainage now carries the water all out of the country. From the citeria at hand the size of this village and the probable number of its inhabitants could not be determined.

No. 18a. On the west side of a wagon road leading from the school to Black mesa, about a mile to the south of the school, indications of ruins supercovered with shifting adobe sand were observed. Fragments of much ancient pottery and indications of stone foundations are being exposed by wind action. About 400 yards further north along the same road pottery shards show in abundance; also what appears to be the rocks of foundation walls of a village are exposed for a considerable distance where the drifted sand has been shifted so as to leave the ancient adobe plain bare. There is not enough exposed in the two exposures to give any idea of the size or shape of this village, or whether or not it is the remains of two ancient villages; neither can the possible number of its inhabitants be conjectured. The site is wholly exposed so far as defense is concerned, but was admirably placed just west of a wide flat which was basined enough to hold water at its north terminus before the side streams of the valley cut out to the master stream and drained the flats. Old maps of this region show a pool at this place. The flats adjacent to this village still show the black loam which was accumulated during a not-far-distant ponded stage.

No. 18b. On the east side of the same road on which No. 18a is situated, and about one-fourth mile north of that ruin, are the remains of a ruin showing potsherds and some accumulated rocks, which probably mark foundations of buildings. It is situated on a slight rocky rise just west of the north terminus of the pocket flat on which No. 18a is situated, as mentioned. The terminal end of the flat shows evidence of even recent ponding. There also seems to be indications that a spring issued from the rock ledge on the margin of this pond in the long ago. The ruin site is covered with shifting earth at the west, so that its approximate size could not be ascertained. It was wholly defenseless so far as the site was concerned.

No. 19. In a little sand flat between two sandrock butte teeth of Comb ridge, about a mile northwest of Kayenta, considerable pottery was discovered in a fragmentary state, intermingled with shifting sand. It apparently was a small village site, probably the home of a single family. One piece of the pottery was yellowish, and was evidently made from material taken from a yellow bluff near by. So far as present water supply indicates, the site was poorly chosen.

No. 20. This is a walled-up cave on the west side of a high butte of sandrock of Comb ridge, about a half mile northwest of Kayenta (Marsh Pass)



Cave, ruin 20.

boarding school. It is situated high up on the cliff's side and was well chosen for protection. A large water hole also exists between this butte and the next butte, 500 yards distant to the northwestward. Wood also is near at hand, as were the valley farm lands. The smoked walls show that it was used as a dwelling. A doll just like the kachina dolls used in the bean dance at Oraibi and Moenkopi was recently found in this cave. It was of wood, the size of a common doll, and painted. My helper, Mr. C. Taptuka, an Oraibi Indian, readily identified the doll and its use. This, as in other cases which will be mentioned later, seems to show that the Hopis occupied this region and these ruins are those left by that race; not by a Horn clan, or a Flute clan of that race, but by the Hopis in general.

Just south of this cave, at a slightly lower level on the same rock face, is the point remains of another cave, which has now been mostly removed by erosion. Its smoked walls attest its having been used by man.

Pictographs on the cliff above ruin 21

No. 21. (On Man's Head Point.) This ruin is situated on a limestone shelf along the east face of a high cliff about one-fourth mile nearly due north of the Marsh Pass boarding school. The cliff is nearly perpendicular. Notwithstanding, part of the buildings at least were not built exactly against it. The cliff offered but little protection from the weather except the westerly storms, but it admirably protected the place from an enemy from the north and west, as it is unscalable and rises 300 feet above the village site. Moreover, the shelf on which the village is situated is 250 feet above the plain (valley of Laguna creek) to the northeastward. The ascent to it was made only over the long slope of the southwardly dipping limestone, where an enemy would certainly have met determined resistance as he was scaling the 25-degree sloping rocks. The place was evidently chosen for protection. The water supply was obtained from what is now Laguna creek valley, near by, most likely from the lagoon mentioned under ruin 11, which is in the flat not 400 yards distant. The lagoon there spreads out eastward

and southward from where the above-mentioned limerock meets the massive Navajo sandstone, where it dips beneath the level of the plain about 450 yards from ruin 11. The farm lands also were evidently those in the flat in the vicinity of village 11. It seems to be evident that the people who occupied those two villages were one and the same. They occupied the lower village in times of peace and the cliff village in troubled times. So far as No. 21 could be determined from surface appearances, eight rooms still remain in the ground plan; also part of another detached stone wall. (See plate 4 for plan of this village.) The walls of a circular kiva also show plainly. The size of the village, however, cannot now be determined, as all of it except that next to the stone wall of the cliff has been wholly removed by wind and water. The writer would judge that at least 100 people lived in this village, though the ruins, as now show, would probably not house more than 42.

The cliff has many pictographs pecked on it. On the wall against which the village was built are twenty-eight drawings of mountain sheep, two chindes (devils), one set of concentric circles, and one uncoiling circle. Back of the benched area, marked 6 and 7 on the plan of these ruins, there are also many more drawings—coiled lightning, mountain sheep, etc. Also, facing this rock on the northeast, at a lower level than the shelf on which ruin No. 21 is situated, are indications that a village was once placed there, but now wholly obliterated. Pieces of broken pottery are found all the way down the long talus slope from the perpendicular face of the cliff to the valley below. The face also has pictographs of mountain sheep on it.

No. 21½. This is a small ruin nestled among the projecting rocks of Comb ridge, across the creek from Nos. 11 and 21. Some of the walls still show.

Nos. 22a-f. In a little nook on the opposite (south) side of Laguna creek from ruins Nos. 13 and 16, to the northwest of a high cliff, there are the remains of six ruins built out in the flat, now being covered with shifting sand. There were probably other villages there, which are now covered with sand or have been removed by the creek's cutting through the flat in recent years. There is now no indication that there was water in the vicinity of these villages in that long ago, Laguna creek being cut since 1881. There is not a spring or a seep near them now. About a mile to the northward, however, there are now live springs, and there are indications that they were more extensive in the long ago than now. Moreover, as there was no drainage for the valley then, the creek channel being of recent date, as we have seen, the drainage of quite a country to the northward must have settled in pools and served as a permanent water supply and also used for irrigation. At that time ruins Nos. 13 and 16 were not separated from these ruins by the sixty-foot-deep Laguna canyon as now. These villages seem to have been placed in these locations northeast of the above-mentioned cliff simply to be out of the wind. They seem, furthermore, to be wholly unprotected from attacks except in their horseshoe structure and thick walls. There were surely but few enemies in the region when they were built or they would not have been built in the open as they were and of the dimensions and size some of them appear to have been. Below is a description of each in detail.

No. 22a. This village is straight in line with Chistla butte and El Capitan, near the sandstone cliff south of Laguna creek, and between it and the creek. It is built along a north-and-south axis. Thirty paces of the west wall show in part. (It was built of stone, both lime and sand rock being used. The width of the village was apparently seventeen paces. (See plate 4 for plan of this village so far as now shows.) The village is now covered with shifting sand. There is much broken pottery; also two sandstone slabs used as arrow straighteners were seen. The village probably contained 100 souls. Indications seem to show that it was not long occupied, as the potsherds are sparse compared with what surrounds many other ruins.

No. 22b. This village is about one-half of a quarter of a mile to the west of No. 22a. The remains are scant. A little wall shows. This and a few pieces of pottery mark the site. It apparently was the home of a single family.

No. 22c. Pottery pieces indicate that there was a village about one-fourth of a quarter of a mile northwest of 22b, which is here designated as above. There are no walls in sight. The ruin was near the jutting northeast corner of the east-and-west wall of the rock promontory where it turns in a short curve to the southeast to make the curve in its contour which incloses the area where the villages (22 a-f) in the main are located. The village seems to have been small.

No. 22d. About 500 yards northeast of No 22a there is quite an accumulation of pottery on a little ridge. No walls show. This village, judging from the pottery fragments, was also small, probably having only about fifty inhabitants.

No. 22e. About 300 yards due east of 22d is an extensive village site, with much pottery and slab-building rock flanking the dune which has now blown over the site. This village appears to have been long inhabited, and probably contained between 100 and 200 people.

No. 22f. Around a point of the cliff about one-half mile east of No. 22e are signs of a village, rock flags, pottery, metates, etc., showing on the surface. Most of the ruin has been removed by the encroaching creek canyon.

NOTE.—Upon the south sloping face of the cliff southwest of No 22a several metates were found, but no pottery These probably represent a burial place where several women were buried. Also about one-half mile due south of No 22f, in an extinct crater, several metates and a few fragments of pottery were found. This also probably represents a grave One of the metates was made of "crenulated" dolmite limestone, and resembles some ancient fresco in "scalloped" figures. It was worn entirely through and had one side gone

No. 23. About four miles north of the Bradley store (Chilchinbito, or Bitter Weed Water), on the western route from Chilchinbito to Kayenta, a ruin was seen on the south front of a rocky bench which faced an east-and-west draw. We were on our way home from burying Mr. Bradley, who had been found dead in his cabin at the store, so had no chance to examine the ruin. Mr. John Wetheril, who was with the party, advised the writer that the nearest water to the site was about a mile distant to the westward. "Just a nice distance," he remarked, "for the Indian women to carry the water." The village was large, judging from the abundance of the pottery fragments. There were also fragments of grinding stones in sight in a greater quantity than is now usually seen about such dilapidated ruins. The ruin is very old, though some of the mound still exists. Built on the south front of the low bench, the site could not have

been chosen for defense. The farm lands of this village were evidently in the valley to the southwestward toward Black mesa; and unless there were other villages in the vicinity there was sufficient land for dry farming near at hand to amply supply the pueblo with food even now, as the villagers then lived. The Navajos have quite extensive fields for dry farming in the vicinity now, where they raise considerable corn.

No. 24. (See plan on plate 4.) This village is about one-half mile southwest of the Marsh Pass school. It is situated on the very top of a low bench, built in a northeast-southwest direction, with the opening to the northeast. The west and southwest walls show very plainly in piles of rock debris. The rest of the walls are hardly discernible. A plaza is represented by a low depression between the walls. The site is not exposed to wash. The west and southwest walls facing the winds are built of rock; the other walls seem to have been built of adobe for the most part. The pottery is scarce and mostly of the black-and-white type and of geometrical designs; only one red-striped piece was obtained. As the village seems to have fallen in ruins and every part of it still remaining on the site, it would probably be a good site to excavate. From the appearance as it now shows, surrounded by shifting sand, it does not seem to have been long occupied; at least the scarcity of potsherds would so indicate. Its debris is about three feet deep. It is almost circular in shape, with a circumference of seventy-eight paces and a diameter of about twenty-eight paces. It probably contained 100 souls.

No. 25. This village is fifty-six paces due north of No. 24, on the west side of the same bench. It is apparently older than No. 24 and was occupied a much longer time, as fragments of pottery are scattered a considerable distance around it. The pottery is of the same make as of No. 24, and it would appear that the same people occupied the two villages, No 25 likely being abandoned when No. 24 was built. The villages were of about the same size. No. 25 was apparently open to the southwest or south, judging from the pile of debris. The ring mound of the old rooms is about sixty paces in circumference. No walls show and no red pottery was found on or near the site.

This village, with No. 24, was built on a raised bench, as mentioned, which would have afforded them some protection. They opened toward each other, which, if they were occupied simultaneously and they were friendly with each other, would also have furnished some protection. To the southeast of these were extensive flats where corn could be raised, and in the years ago there was a pool in that vicinity that could have afforded water for irrigation. Besides, the washes from Black mesa then had no outlet as now, so that their accumulated waters could be used for irrigation. The pool has been drained by canyon cutting since the coming of the white man. They also could obtain water for the villages from the springs along the bluff at Kayenta and the Marsh Pass school, the same as is now used by the school and teachers. Also, all along the bluff from the vicinity of the stockman's residence to quite a distance east of the school there are seeps and springs from which those far-off people likely irrigated quite a considerable area of land in the valley flats now occupied by the city of Kayenta and the Indian school.

No. 26a. (See plan on plate 4.) This village is nearly half a mile nearly due south of village No. 24. It was of large dimensions. Its west and southwest outer walls were of stone. The other walls were probably of adobe. A plan of

the village can now be traced. It was in a somewhat parallelogram to rectangular in shape, with the north end apparently open, the village being built mainly on an almost north-and-south axis. The east limb of the wall was twelve paces in length, as now shows; the west wall fifty-four paces. The closed end of the village was extended outward somewhat toward a circle segment and is forty-six paces in length in outer wall. The east and west sides of this village cannot now be traced farther than stated above, but scattered potsherds indicate that the village extended quite a distance eastward and also northward, but was of adobe construction, which has crumbled and been blown away by the winds. It probably contained 100 inhabitants when at its zenith. It was built in the open flat and had no protection except its own walls. There was no water within half a mile of it for domestic use, the springs at Kayenta being the nearest. About a half mile to the southwestward there are signs that there was once a pool, a black loamy spot now covering the site. There was also the pool of water to the eastward, mentioned with villages Nos. 18a and 18b, and also the extensive flats, also mentioned with the descriptions of those villages, which they likely farmed. There was also lands to the westward between it and villages No. 15a, 15b and 15c, which were also probably farmed.

No. 26b. (See plan on plate 4.) This village is also in the flat about a quarter of a mile nearly due north of No. 26a. It is without any natural protection and probably used the same farm lands and fields as that village. This village was rectangular in shape with east face open. The west outer wall was of rock. There seems also to have been three large rooms constructed wholly of rock, each now making considerable of a mound. The mound marked *X* within the ruin about the middle line of the north wall (see plan) was probably a kiva. That the village had square corners is only conjectural. The rocks of this village and of No. 26a had to be carried about a half mile. This village was apparently more compactly built than 26a, and also had the three solid stone rooms mentioned. It probably never contained over 100 inhabitants and likely not half that number.

No. 27. Just back of the little ridge about a quarter of a mile southeast of the school is quite a collection of broken pottery exposed in a ravine, which probably marks the site of a small village, which is all but obliterated.

No. 27½. About due east of the school, about half of a quarter of a mile distant, on top of a little point in the flat, are considerable potsherds and other indications that quite a village once occupied the site. The little mound that shows is probably the remains of the village debris.

No. 28. About a mile southwest of ruin No. 26a, on a little elevated spot of land, there is quite a bit of pottery, also the outline of the west wall of a village, extending a distance of fourteen paces. This village was never extensive and was not inhabited for any length of time, judging from the scarcity of pottery fragments. Probably twenty-five people lived in it. Near it to the southwestward is a square of two and one-half feet to the side, inclosed in rocks set on end.

No. 29. This ruin is on the eastern point of a low mesa about one-half mile southwest of No. 28. Parts of the walls of two rooms on the eastern front of the mesa still are intact. They are of stone. The village, however,

was of adobe construction and was large. On account of the shifting sand, which has covered the debris from a depth of from one to five feet, its exact size cannot be ascertained. The pottery shows for a distance of 400 yards in a southwest-northeast direction and also in cross section more than 100 paces. The pottery, where the wind has blown the sand off, shows in large quantities and indicates that the village was large and that it was occupied for a long period of time. Judging from the size, if the whole area was occupied simultaneously at least 500 people must have inhabited it. Its east wall, which stood on the east brink of the mesa, was undoubtedly of stone, as the few remaining walls indicate; stone was also plentiful on this point in scattered form. The rest of the walls were of adobe. A peculiar thing in the outskirts of this village to the northward was noticed Where the wind had whipped the sand away little isolated mounds of rock were exposed, about which there was much broken pottery. The writer takes it that these were graves of women and that the culinary ware of each lady was broken on her grave, as most of the rock fragments were of broken grinding stones and other kitchen ware, including a great amount of broken pottery. This village, like No. 28, and also like No. 30, which will be described later, was wholly unprotected so far as its location was concerned. As to the farm lands of the village, it undoubtedly used the flats to the eastward, the same as villages Nos. 24, 25, 26, 27 and 28. Their nearest water was either in the foot of Black mesa or at Kayenta, and possibly pools on the flats which are now dry. A stream bed (dry wash) comes out from the mesa about two miles distant to the southward, where now in wet weather the water spreads out over a large area and sinks. In the time of this village it is likely that the water of this wash was kept more confined by damming, and by it a supply of water was maintained. Several dry potholes are seen in the vicinity, which also likely contained water then. A peculiarly painted pottery was found at this village. The painted part was in slightly raised relief, and was also peculiar from any other the writer has seen. The characters used were different. The writer also found one piece of pottery of the corrugated type, that had a raised relief near the upper rim that was intended to represent the common snail of the country. Fragments of metates and manos were also common.

No. 30. This village is about one-half mile southeast of No. 29, on a slight elevation of land which is now overcapped with shifting sand. The delineations of the ruin could not be made out, but, judging from the scattered potsherds, it must have been several hundred paces in diameter. There is some stone on the site which was carried from the vicinity of No. 29, but the walls in general must have been of adobe. Judging from the pottery fragments, at least 100 people lived in this village and must have occupied it for a considerable number of years.

About 300 yards east of the ruin the writer found a grave, which seemed to be that of a woman, as it contained the fragments of a large storage jar, a pair of manos and a metate.

About one-quarter mile nearly north of this village, out in an adobe flat, a small mound of rock sixteen feet in length by six broad was observed, about which there was some broken pottery, also some scattered rock. The writer judged that this was either a grave or the remains of a single-roomed stone house. If a grave it must have been that of some dignitary.

No. 30½. This is a village out in the flat east of the arroyo west of which Nos. 29 and 30 are situated. It is also about a half a mile northeast of villages Nos. 61a, 61b and 61c. It was a small village, probably never containing more than twenty-five people. It was circular and was built of adobe. Its people depended on the water of the same arroyo as Nos. 29 and 30, using the same to irrigate the adjacent flats. The site is now a broken-pottery-covered mound.

Nos. 31 to 34. These villages are just to the west of Laguna creek, over the rocks of Comb ridge northwest of the school, and are all perched on a sand ridge. All were without defense of any kind except their own walls. A part of the walls at least were of stone, the stone being carried at least a quarter of a mile from the mesa walls to the westward. The villages are on the north side of the gorge, where the creek cuts through Comb ridge on its northern swing east of Moqui rock, the rock walls inclosing the narrow valley being high on either side. Why the villages should have been perched on this wind-swept, sandy ridge instead of on the neighboring adobe flats, which are protected from the wind, is a puzzle. At the time of their occupation the uncrossable sixty-foot-deep canyon of Laguna creek, which faces them on the east, and its side canyons did not then exist. It would seem that since their abandonment the stream flowed for a long time at a level much higher than now, the old bench flood plain being of adobe instead of sand. The farm lands of these people must have been in the vicinity of Kayenta and also in the flats where the present creek flows, also to the northwestward near ruin 35, which will be given later. At the present time there are no springs in the vicinity, and as the creek did not flow there then, it is quite a quandary where they got their water for village use. Probably they had dams in the flat east of the sand ridge to the mesa to the southward of the present creek channel, where water was impounded.

Below are notes on each respective village.

No. 31. This ruin, as now shows, was small. There are some pottery fragments and a few rocks. Nothing is now in place. From the ruin as can now be seen, it never contained more than twenty-five people. Near this ruin was found an altar. It was in rectangular shape, inclosed in stone slabs set endwise in the ground, and apparently had been formerly inclosed with a capping lid. In it were broken pottery, flint chips, and the like. It might have been a child's grave over which these things had been placed. No bones were found in it, which seems to indicate that it was an altar instead of a grave.

No. 32. This village is 401 yards north of No. 31. It is situated on a little eminence of sand (or probably time has removed the surrounding original surface of the region till the peak protected by the rock of the village is all that is left of the former plain). It was built partly of stone. The original foundation walls of some of the rooms, especially on the southwestern edge of the village, are still in place. The southwest room is now quite a rock mound. The remains, as now exposed, are 32 paces in a southwest-northeast line and sixty-one paces in a northwest-southeast direction, as shown by the pottery fragments and walls. There is much broken pottery; also an altar near it, like that described under No. 31. There also seems to have been a large stone building about 100 yards to the eastward of the village.

No. 33. Across a 50-foot-deep ravine, about 400 yards north of No. 32, are the remains of what was once a stone village, built on a sand point of land. The main mound here is now in a northeast-southwest direction, and, as it now remains, is only about two rods long. About two rods east of this mound is a foundation wall in a nearly east-and-west direction still in place. Either it was a smaller village than No. 32 or most of it has been removed by erosion. Probably no more than twenty-five people ever lived in it. The scantiness of pottery fragments also indicates that it was not occupied long. A large pestle was found here, one of the largest the writer has seen; but, unluckily, some unknowing Navajo had mutilated it by chipping.

No. 34. This village is about a half a mile a little east of north from No. 33. It was built partly of stone. It was found to be covered with a heavy blanket of sand, so that its size could not be determined.

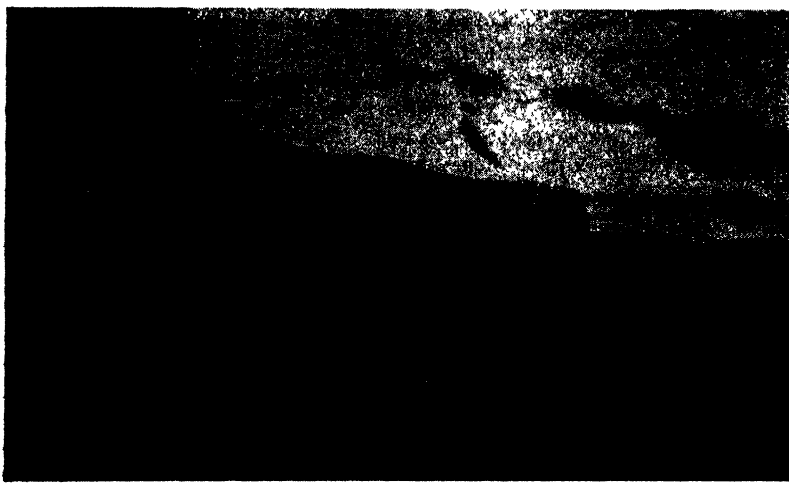
No. 35. This is a cliff ruin along the east face of the mesa that closes in Laguna creek valley and canyon here. Here two layers of massive sandstone are separated by a shaly layer less than four feet in thickness. The wall runs nearly north and south and the upper series projects over a little. The ruins are on the upper surface of the lower sandrock and fill the space between it and the sandrock above, to the depth inward that the shaly stratum had weathered, which seldom exceeds ten feet. The village when in the height of its power was fifty-six paces long and one room space deep. At the present time two rooms are wholly intact. One has an eight-foot front, four feet high in front, and rear height three feet; depth into cliff about ten feet. This was a living room, as the smoked walls indicate. The other room is four feet by three feet by a depth into the mesa of three and one-half feet. It must have been a storeroom for religious things. Parts of the walls of two other rooms show. The "front yard" of these rooms was a stone ledge less than two and one-half feet wide, and at the time of the occupation it must have been ten feet to the ground beneath the ledge. The cliff is now much broken and sheep have been occupying the shelf. Near the south end of the village on the face of the cliff there are twelve crude drawings of a hand in red, the drawing of a crude figure of a man dancing with dangling fox skin in chiseled outline, also several other crude drawings of human beings with tails like a fox, also in red. A large boulder near by also shows sixteen places where tools were sharpened or straightened. No pottery of any kind, fragments or otherwise, could be found. This leads the writer to conclude that the village was hurriedly built and never occupied. It was probably built for defense, like the village of Mesa, Colo., west of Jemez, N. M., that was built by the Sia during the troubled times following the Pueblo revolt of 1680.

About a half mile south of No. 35, along the same rock face but in the valley adjacent, some fragments of pottery were observed; but as the sand blown over the top of the mesa from the west had the whole east front of the rocky cliff submerged here in a deep sand dune, it could not be determined whether a village had been there or not.

No. 35½. This is a ruin under a cliff, up a small canyon, over a point about a mile to the westward of No. 35. It is high upon a shelf under an overcapping hood of rock. It was quite an extensive village. It has suffered much by the ravages of time and is now in a very dilapidated state.

Nos. 36 to 43. On the west side of Laguna creek are villages Nos. 36 to 42, while No. 43 is on the east side. All these are in the narrow valley where the creek cuts through Comb ridge in its northern turn east of Moqui rock, on which ruin No. 10 is situated. Villages Nos. 31 to 34, and likely No. 35, previously described, are a continuation of this series, including also No. 10 on Moqui rock. The general remarks on Nos. 31 to 34 apply to these villages as well. The writer wishes also to add that none of these ruins are on the first bench of the creek. It might also be added that it is the writer's opinion that the whole series of villages were made by the same people during a long period of years.

These villages, on account of the narrowness of the valley gorge here, are all much nearer the rock walls which inclose the canyon than Nos. 31 to 34 were, some being almost against it. Yet but little or no stone was used in the construction. A few square-shaped stone shrines were found, which now



Cliff house, ruin 35

contain no curios. The ruins are all very old, as are ruins Nos. 31 to 34. They were constructed of adobe, each inhabited for a more or less extended period of time, then abandoned. They were then completely demolished, so that no walls were left standing. Then, as indicated in several places, from five to ten feet of loess or sand was piled over them, as over the rest of the valley. Then came the renewed canyon cutting and the removing of the sand and loess from over the ruins. Where any quantity of stone was used in the construction the denudation has been checked; even the pottery fragments have more or less checked it, so that to-day the village site is a little point of land from which dry gullies slope every way. The first bench of the creek course of the present time was probably swampy in the days of the villages; the creek canyon of our day did not then exist. Below is a description of each village in detail.

No. 35. Five hundred yards northeast of Moqui rock, ruin No. 10, the remains of a ruin shows beneath the shifting sand on a sand point to the north

(west) of the creek. Its dimensions could not be determined. Pottery fragments, metates and broken manos are strewn over the site. One whole, large metate for seed grinding was seen. The scattered pottery extends over 100 yards on the top of a little loess knoll in a northeast-southwest direction. Then the west stone foundation of a room is exposed, extending seven paces in a north-south line. To the south of it are the remains of a smaller room. From this place the village also extends eastward and southward 100 yards more, a deep ravine now cutting the village in twain. The whole site is much dissected and there is every indication that the ruin is very ancient. But very little stone was used in the construction. Toward the southeast terminus another mortarlike grinding slab of large proportions is exposed, also a broken metate. The pottery also increases in broken fragments toward the southeast. West of the stone house mentioned the houses seem to have been isolated; and again, after crossing a little valley to the eastward, a very recent ravine, the village still extends more than 100 yards further. Toward the southeast part of the latter division a large, slightly worn metate was seen, also several fragments of metates and manos. The loess and sand points still standing extend often as high as five feet above the debris of the village, now being rapidly degraded. The dimension from southeast to northwest is 225 paces, and from east to west, including the extension east of the ravine mentioned, something like 400 paces. On account of the denudation of the knoll on which the village was located, no idea of its original size could be determined. If it was all inhabited at one time it must have had a population of over 500.

No. 37. This ruin is about one-eighth mile northeast of No. 36. It is a small ruin perched on an adobe point. A part of a large, coarse-grained metate and much broken pottery are exposed. Most of the village has undoubtedly been removed by erosion. No walls or foundations now show. About 400 yards northeast of it is a pool of water held in by a sand dune that has blown over an adjacent cliff to the westward.

No. 38. This ruin is about 100 yards east of No. 37. The two were probably continuous in the old times. No walls show. A large mortar of sandstone, eight inches high, eighteen inches across, with mortar orifice over a foot across and six inches deep, sits on top of the ground. The top of the knoll on which the village is situated and the slopes of same are strewn with great quantities of pottery fragments.

No. 39. About 400 yards east of No. 38 are much broken pottery, a very large broken metate, some stone, but no wall of any kind shows to indicate the size of the village. It must, however, have been small, as there is not pottery enough to indicate that it was very large.

No. 40. Nearly a mile northeast of No. 39 there is a village site of eighty paces in length in an east-and-west line. It is situated on a narrow ridge that is being gradually cut down on both sides. Much stone was used in the construction. A square shrine, 2 feet by 2 feet, incased in rocks placed on end, was observed at the northeast terminus. The original size of the village cannot now be estimated.

No. 41. About 300 yards east of No. 40 are the remains of what seems to have been a single stone structure with outlying rooms of adobe construction. It was a small affair and probably had but one family occupying it. It was never occupied long, as the fragmentary kitchen ware is scanty.

No. 42. This village is about 200 yards northeast of No. 41. It is on the south edge of a bluff, facing the first bench of the creek. It is now mostly washed away. The remains show it to have been 100 yards in a northeast-southwest direction. There is much broken pottery. No walls were seen.

No. 43. The remains of a small village were found near the mesa walls of Comb ridge on the south side of the creek, about due south of No. 42. No walls now exist, only broken pottery and broken grinding stones. It probably contained twenty-five people.

No. 44. Just south of the Kayenta - Marsh pass wagon road, about a mile and a half west of ruin 16, in the vicinity of Porras dikes, pottery fragments exposed beneath the shifting sand give indication that a very ancient village once occupied the site, but was wholly in ruins and its adobe walls carried away by wind and water before the sand overspread the region

No. 45. About a mile southwest of No. 44, on top of a bench mesa, is a small ruin whose entrance was from the west. The circumference of its walls is 110 paces. Its northwest and southwest parts were of stone and now show as low mounds. Many pottery fragments are to be seen in the vicinity. The people of this village and of No. 44 had no living water within a mile of them, as there are no signs that water ever stood in the flats adjacent. Also, from indications, their farm lands were at least a mile from the sites. They were each wholly unprotected from attack so far as natural protection was concerned, though they were undoubtedly protected by village walls Neither village contained over 100 souls, and probably not over 50.

Nos. 46 to 51. These villages might be termed the "Government Hay Meadow Ruins," as No. 51 extends to the east fence of the government hay farm between Kayenta and Chilchinbito. These ruins are all in an extensive flat between two high mesa extensions of Black mesa, which completely walls in the valley near No. 51. A line of isolated buttes, finally extending into the rock wall of Black mesa to the westward, separate this valley into two parts to the eastward. One the south side of this line of buttes is an elevated adobe bench, the banking of debris that runs off of Black mesa on that side. This bench flat must be a mile wide and extends many miles to the eastward. The deposit is dark in color and is good soil, but on account of the lack of rain it is wholly barren. Villages Nos. 47 to 50 are on the north face of this deposit bench. No. 51 is in the foothills just north of the western flats of these deposits, at which place they are covered with native grass. No. 46 is to the north of a little sand ridge in what was a continuation of the same flat before the coming of the sand, which has been deposited by wind action in the lee of a point of the mesa wall to the westward. North of the isolated buttes and villages Nos. 47 to 50 is a low, flatlike swale of several hundred yards in width and miles in length in an east-and-west direction, being walled in at the westward by high walls. This swale-flat is from six to ten feet lower than the bench on which villages Nos. 47 to 50 were built. It shows signs of once having been boggy and of once having contained springs, but the whole low area is now dry and covered with grass. An ancient dam can be traced about sixty paces east of No. 47, by which water was impounded here for village use and for irrigation; but there is no water there to impound now with the exception of that from the melting snow and occasional summer showers. A

properly constructed dam, however, would likely impound much water here now. One thing was noticeable the past year: It rained in this section and in the vicinity of the head of Three Mile wash more often than any other section in the region. The clouds, backing up against the 1,200-foot walls of Black mesa, would shower in these two places day after day. With water to irrigate with from this dam, and likely from other dams constructed in the region, which time would not permit the writer to find, the people of these villages had fine and extensive farm lands at their command. So far as defense was concerned, these people had none except what the walls of the village afforded. None of the sites afford any protection whatever. In fact, they were placed in the most exposed places in the vicinity. It would appear that they had no enemy to fear or they would not have built their villages in such exposed positions, especially when the valley was closed in with mesa walls and a line of high buttes intersects the valley flats, on any or all of which they would have been safer from attack than in the open valley; but not a butte or an adjacent mesa, one being not 400 yards from the villages, has even a piece of pottery on it. The abandonment of these villages was possibly due to the shortage of water, as, with the exception of No. 51, none of the villages now has a drop of water in miles of them But as they had at least one dam to retain water, it is more likely that they were compelled to abandon the region on account of the coming of a numerous enemy. Below is a description of each village in detail

No. 46. This village site is in a flat between a sand-dune ridge on the south and a mesa wall to the northward that also closes in the area to the westward. The ruin is very ancient, existing so long ago that the mound of the village debris is entirely flattened out to a level with the flat area in which it is situated, and the pottery, where there is no wash, is scattered in all directions many hundreds of yards. Considerable stone was scattered over the site, which indicates that stone was used in part in the construction. Fragments of kitchen ware were seen all about the site. The village was small. There are no signs of any water ever having been near it north of the sand dune, but south of it, as we have seen, is the site of the dam east of No. 47. It is the writer's opinion that at the time the village was inhabited the dune, which is now from ten to twenty feet high and several hundred yards in length, did not then exist and that this village obtained its water from the same draw as villages Nos. 47 to 50 did. The writer believes this village is much older than any of the other villages of the series.

No. 47. This ruin is on the north front of the adobe bench facing the swalelike area to the northward. It was built partly of stone and has much kitchen debris in broken pottery and grinding stones scattered about. It was a small village. Near it and a little to the east is the remains of the dam previously mentioned. It was built directly across the swale in approximately a north-and-south direction. The part still remaining is a conspicuous mound built partly of stone.

No. 48. This ruin is one-fourth mile west of No. 47. It is similarly built on the north front of the adobe bench, facing the above-mentioned swale, which shows signs of once having been boggy and swampy. The village was built in the form of a parallelogram, sixty-three paces in an east-and-west line and probably a width of half that in a north-and-south direction, with

several outlying rooms. It was widest at the east and was probably open at the northwest. Considerable stone was used in the construction, especially along the north wall. The east-and-west rooms seem to have been mostly of stone, judging from the piles of stone now existing. A whole metate, several broken ones and much fragmentary pottery were observed. It is not likely that as many as 100 people ever lived in this village at one time.

No. 49. Seventy paces west of No. 48, on the north edge of the same bench, is a village 105 paces in circumference. It was open to the northeast, with opening 20 paces wide. The main buildings were at the north and west. They were of stone, now represented by low mounds of rock. Much broken pottery was observed.

No. 50. About 500 yards west of No. 49 is much broken pottery, several metates and other fragments, but no walls were indicated. It would seem from the appearance of the remains that it is an ancient graveyard. It would necessitate much excavating to determine its status.

No. 51. This village is on a little knoll in the piñon cedar timber just east of the fence to the government hay lands, on the foothill slope, about 400 yards northward from the flat meadow lands and about the same distance south of the eastern projection of Black mesa. The ruin is circular, 28 feet by 28 feet in cross diameter, and is flat on top, on the top of which are clumps of greasewood. Some stone was used in the construction. No pottery is shown on the top of the ruin, but is scattered all around it. The village makes a conspicuous mound and is undisturbed.

No. 52. This ruin was shown me by our missionary, Mr. L. Segar. It is across the wash of Laguna creek northwest from the volcanic plug, Black rock, northeast of Kayenta. It was built against a cliff and was properly a cliff house, leading toward the cave type. It was not large, but evidently, from the rock markings, was at least two stories high. Pottery and rocks of which the wall was built are scattered about the site. The writer recovered the handle of one jug that was made of twisted strands of mud. Just above where the floor of the second story would come there are flaring holes in the rock face. These are an inch across at the base. There are also about forty round holes about the depth and size of a thimble. These probably represent the sockets of spinning sticks. There are many glyphs on the walls, among which are that of a mountain sheep, a hand, the sun, etc. The mesa walls at the base are much smoked.

Nos. 53 to 60, and 60½. These ruins lie in the flat northwest of Moqui rock (ruin No. 10). Nos. 53, 54 and 55 obtained their village water supply from the branch creek that here enters the flat from the foothills to the northward and now joins Laguna creek near and to the westward of Moqui rock. No. 60½ also obtained its water supply from the same source. No. 60 received its water from springs in the breaks in the Segi mesas adjacent to the northwestward. The remaining villages got their water from pools caused by sand dunes damming up the watercourses. Water for irrigating was probably obtained for a part of the villages from the branch creek mentioned. The others undoubtedly raised crops by dry farming and by the flooding of the flats by the flow of water down the southern slopes of the rocks to the northward during occasional showers in summer. A considerable area is now cropped by dry

farming and flooding in this vicinity by the Navajos with success. None of these ruins were placed in suitable places for defense, though all top sand-dune areas. Little or no stone was used in the construction. Below is a description of each village.

No. 53. This ruin is just north of the road on a little mound of dune sand northwest of Moqui rock, just before entering the north branch of Laguna creek from the east. The mound is now nearly washed away. Its slopes and top are covered with scattered broken pottery. No stone was used in the construction of this village. Its size could not now be estimated, but it evidently was a small village.

No. 54. This was a rather large village, about 400 yards southwest of No. 53, on the opposite side of the branch creek mentioned. It was built of adobe and was wholly in ruins, the walls being entirely leached away before it was covered over with sand-dune material. Its pottery is scattered far and wide, reaching to the walls of the creek. It probably contained 100 or more people. It seems to be very ancient.

No. 55. This village is about six rods west of No. 54, topping a sand dune. It is not so large as No. 54, but appears to be as ancient. It was built wholly of adobe.

No. 56. This was a small village about a half mile west of No. 55. Some stone was used in the construction.

No. 57. This village is considerably over a mile from the last. It topped a sand knoll, which has been nearly removed by the wind. The east wall of a part of the village, which was of stone, is still extant, but the rest of the village site has been obliterated, leaving the slopes of the ridge streams covered with village debris, potsherds, etc. The people of this village evidently farmed the same area and obtained their village water from the same pool as ruin No. 58, as will be given later. The village was small.

No. 58. This ruin is on the top of a mound of loess about a half mile a little south of west of No. 57. This loess dune had closed a little valley northeast of the village, where even to this day there is a pool of water. They also farmed the land adjacent to this pool to the northward, which is to-day the cornfields of the Navajos in the vicinity. The crops were likely raised by dry farming, as previously mentioned. Some stone was used in the construction of the village. The stone had to be carried quite a distance. The village was small. No walls now show.

No. 59. About three miles west of No. 58 are pottery fragments scattered over quite an area, but no village now shows. The site is the top of a sand dune that impounds water to the north of it.

No. 60. This village is one-fourth mile east from an inverted V point on Comb ridge, where this ridge breaks off from the Segi mesa about due west of Moqui rock. It was circular, the plaza or kiva now being a depression. It was open to the west. Its principal walls were on the east side of the depression, where there is quite a mound, around and over which considerable broken pottery is scattered. The village was small, its diameter hardly exceeding thirty paces. It is on a little knoll between two dry washes and faces a gap in the rock walls directly northwestward, from which there were springs in the old times. This village, at least its western part, has been

much disturbed. The remains of a Navajo sweat house now cover this portion.

No. 60½. This village lies to the west of the north branch of Laguna creek, that enters that creek just west of Moqui rock, as we have seen It tops a bench just west of Yellow Head's hogan and corral. It was quite an extensive village, now represented principally by its numerous pieces of broken pottery.

Nos. 61a, 61b, 61c. These villages are all some distance northwest of a dry wash which comes down off of the mountain (Black mesa) past Crank's stone house and spreads out on the flat about a mile northeast of the lowest village. This date (April 30) the writer followed the wash to its head, and though it had just rained three days before (April 25-27) along the mesa where it heads, it had not a drop of water in it from its source to where it vanished in the alluvial fan on the flats north of the villages, after running a course of several miles. In its middle course to below the last village it has been deepening its channel recently; but if dammed now at any place along its course it would reservoir water only for a short period after each rain. Yet it must have been from this wash that the villages obtained their water for domestic use. It is a known fact, of course, that certain Pueblos carry water for miles to their villages now, the springs at Kayenta being nearer these villages than the water-supply places are to many villages of our own time. The stream flattens out now, but leaves no water pool There are no springs within miles of the place. The fields were likely on the flats to the north and northeastward. The crops were likely raised by dry farming with the aid of the flood waters of this wash during occasional summer showers. None of the villages are located on a defensible site. In fact, the upper village was built down in the flat adjacent to the walls of the west inclosing bench, so near it that an enemy on the bench would have commanded the entire village. Below is a description of each.

No. 61a. This village, the lower of the group, is about due south of Kayenta and about 1½ miles south of Black mesa. It is situated on the north end of a sand knoll northwest of the above dry wash, from which it is about 400 yards distant. It appears to have been quite large and to have been very ancient, the oldest of the group. It was built of adobe and was wholly destroyed before the dune sand, which now covers it to a depth of from two to three feet, was blown over it. No walls or mound show, but broken pottery is scattered over a considerable area.

No. 61b. This is a ruin one-fourth mile southwest of No. 61a on the same ridge, and about the same distance from the wash. It appears to have been built of two sets of stone buildings, which lay east and west of each other, respectively, and are now represented by north-and-south low-lying mounds of rock on which there are Navajo altars. The rocks had to be transported quite a distance for the buildings. The distance from the east side of the east mound to the west side of the west mound is thirty-two paces. Adobe walls completed the village, which was in horseshoe shape. It was seventy-nine paces in circumference, with opening of ten paces toward the southeast. Much broken pottery covers the site. Southeast of the village about 100 yards the wind is whipping the sand off of much broken pottery, which the writer believes exposes their graveyard site.

No. 61c. This ruin, abutting the west mesa that closes in the little valley of the wash mentioned, is in the flat, about one-fourth mile southwest of Mr. Crank's stone house, and probably a mile southwest of ruin No. 61b. The west, horseshoe-shaped part of the village was of stone, the semicircular foundation of which still remains, twenty-eight paces in length. The eastern part was apparently of adobe and stone. It is now completely obliterated except for a slight mound. The village was apparently open to the southeast. Its diameter from east to west is forty-one paces.

No. 62. This ruin is 400 yards west of ruin No 15c. The latter is on top of a butte, to the west of which are the remains of a low ridge. No. 62 is on this low ridge, which extends in a southwest-northeast direction to the southwest foot of the above butte. Most of the pottery shows on the east side of this ridge, probably marking a graveyard site. West of where the pottery is most exposed is a circular mound of a circular village 104 paces in circumference, with hollow plaza now showing. The walls were of stone and now stand four feet high The village was open to the southeast. From the south limb of the east side a large stone addition projected southeastward, now a stone mound four feet high. This ruin is undisturbed, except that Navajos have erected an altar in the east suburb. There is much broken pottery of large pieces, also many manos and broken metates. From this circular ruin the ridge is strewn with pottery and house remains and parts of walls to the very foot of the butte on which No. 15c is situated. This shows that a village or villages once occupied the entire ridge. If it was a continuous village simultaneously inhabited, 500 people must have lived in it It is the writer's opinion that the circular part was the last village erected. A line of high buttes leading southwestward from this village (see plate 4) shows no signs of having been occupied by village sites.

Nos 63 to 79. (See "Ruins encircling Moqui rock point," plate 4)) These ruins are situated in the valley of Three Mile wash. None were protected except by their own walls All likely farmed the land of the valley of this wash and also got their water supply for village use from it and from Laguna creek basin, though no creek then existed there. Kayenta springs (or Tyende springs), a quarter of a mile northeast of Moqui rock, no doubt existed then as now, coming to the surface of the flats then instead of in the bottom of Laguna canyon as at present. If they had fortified villages then for protection in case of attack they were villages Nos. 15c and 10, the one on butte 15c and the other on Moqui rock. At the time these villages flourished Three Mile wash spread its waters out over a wide flat in the rainy season. The flat was a half mile to a mile in width and several miles in length, as is attested by the debris it left, sand ridges, mud flats, rows of cobbles, etc. It had aggraded its flood plain from ten to forty feet. Now that it has an outlet through Laguna creek, it has cut a deep canyon all the way through its own deposits and is chiseling in the underlying rock. The abandonment of the region by the villagers was not due to this stream's drying up, as it still had no outlet when the white man first came to the region, and instead was dotted by pools along its course. These villages, except No. 63, were built on adobe flats, or the sand piles on which they were built have since been blown away with the dirt of the adobe walls. In the case of most of them not one stone is left on another, and even the village mound has been blown away, leaving the broken kitchen utensils to declare the spot.

No. 63. This ruin is on a low sand ridge about one-fourth mile north of ruin No. 25, on the bench to the southward. No stone was used in the construction. No walls can now be traced and no mound now marks the site, over which much broken pottery is scattered.

No. 64. This ruin is on the east side of Three Mile wash, about a half mile south of Moqui rock. It was a small village, now completely leveled. Much pottery is scattered about the site.

No. 65. On the road about 400 yards east of the crossing of Three Mile wash is a small village, twenty-seven paces by twelve paces, planned in a north-south direction. It was apparently one building. Some stone was used in the construction, and quite a mound covers the site.

No. 66. A village site 350 yards north of No. 65 shows the skeleton remains of an extensive village or villages. The debris covers more than half an acre and probably represents at least three villages. Some stone was probably used in the construction of the foundations, but now no walls or mounds remain, only profusely scattered debris, stone, potsherds, broken metates, manos, etc. If it was a continuous village the site would indicate that it must have contained 1,000 inhabitants.

No. 67. This site is about 200 yards north of No. 66 Much pottery is scattered over a large area. One part of it, covering an area fifteen by thirty feet, has an immense amount of it, as though it might have been a storage place for death urns, containing the ashes of the dead. So far, however, the writer has not heard that these people practiced cremation.

No. 68. This ruin is northwest of No. 67. It shows scattered pottery fragments and some rock, but no defined village site at the present time.

No. 69. The site of this ruin is north of No. 66. The scattered pottery covers a wide area. The remains of a stone wall fifteen paces long, running in a north-and-south direction, still remains as a low mound. Much broken pottery, metates, manos, and a whole, large mortar were seen on the site.

No. 70. This site is thirty-seven paces northeast of No 69. The village extended in a north-and-south direction about eighty paces and was probably half this in width. Adobe mounds cover part of the site, the village evidently being built mostly of adobe. Navajos have built a sweat house, altar and hogan on the northwest part.

No. 71. This is a small ruin north of No. 70, of which it might have been a "suburb." No walls can now be traced.

No. 72. The site of this ruin is about 100 paces north of No. 71. The broken pottery covers an area fifty-nine paces in an east-and-west direction and about eighty paces in a north-and-south direction, with scattered remains of rooms still extending northward. Some stone was used in the construction. The outline of quite a bit of the west wall shows. Much pottery and broken metates mark the site. It seems to have been built in nearly rectangular form and have been open to the northeast.

No. 73. This ruin is sixty paces northeast of No. 72. It was a small village.

No. 74. Occupying the site of the top of a rock knob across the creek southeast of Moqui rock and about 300 paces north of No. 73 is a village ruin of considerable proportions. A depression at the west and also near the middle of the site probably mark ancient kivas.

No. 75. This site is about thirty paces east of No. 72, representing a small village.

No. 76. This village is southeast of No. 72. It is thirty-nine paces in a north-and-south direction, built in horseshoe shape, open to the north. Lines of rock show the sites of the walls. The scattered potsherds do not indicate that this village was long occupied, as they are scanty.

No. 77. About one-fourth mile east of No. 76 is a small ruin that seems to have been a "long house," twenty-four paces long by twenty-four feet wide. It was built of rock, which was carried over half a mile. Many pottery fragments mark the site. There is also evidence that adobe additions extended northward quite a distance.

No. 78. This is a small village between No. 77 and the next village to be described. Some stone was used in the construction

No. 79. This village lies south of the wagon road from Three Mile wash to Kayenta, about one-fourth mile south of No. 77. It was small and circular in form and was built partly of rock. Much broken pottery marks the site.

No. 80. This village is about one-fourth mile east of Nos. 77 and 78. It was very small and was unprotectedlv built in an adobe flat. Its construction was partly of stone. Its site is now wind swept Its postherds are much scattered.

No. 81. This is the remains of a ruin about due south of Moqui rock. It is on a little knoll. Much broken pottery, metates, etc., mark the site.

No. 82. This represents what appears to be a series of ruins, running along a sand-adobe ridge from southeast of the east terminus of the present reclamation dam westward to the junction of Three Mile wash and Laguna creek, south of Moqui rock. The creek is undermining the ridge and carrying it away toward the west. No village walls appear and no definite village mound, but large quantities of village debris, potsherds, etc, are exposed in different segments of the area, each of which probably marks a small village site. The sand is blown off of the ridge all but at the eastern terminus. If it represents a continuous village it must have housed at least 500 people. As is the case with all the ruins in this vicinity, it apparently is very ancient.

Nos. 83 to 93 (See "Ruins encircling Moqui point," plate 4.) These are what remains of very ancient ruins west of Three Mile wash. Most of them are on adobe wind-swept knolls, and only metates, etc., remain to mark the spot. As noted, they are all very ancient, and probably were built when the area was a flat, level region covered with sand dunes, all of which have now been swept away by the wind and by the flowing water which now seeks the creek and wash which have been cut since the days of the villages. The villages protected their sites from denudation; hence now are mounds, separated by slopes and gullies. At the time of the villages Three Mile wash turned westward and was impounded in the area now known as "Crank's farm" and other low areas extending on westward. The sand-adobe ridge which impounded it has just recently been cut through by the stream.

No. 83. This ruin is on a small knoll just north of Crank's cornfield. It seems to have extended much to the westward from what can now be definitely determined. It was built partly of stone, and apparently, judging by the scanty pottery fragments, it was not long occupied.

No. 84. This is a small ruin a little to the north of No. 83. It was evidently built wholly of adobe, all of which has been blown away, leaving pottery fragments scattered over the site.

No. 85. This ruin is on the west side of Three Mile wash, near its junction with Laguna creek. All that is now left is broken pottery and scattered rocks.

No. 86. The site of this ruin is on the bank of Laguna creek, 500 yards north of No. 85. Much broken pottery marks the spot. The creek has likely removed considerable of the village site.

No. 87. This is a village site on a low rise of ground. It is about 400 yards southwest of No. 85. There is much pottery here, but it is all broken into very small bits, which seems to indicate that the village is very ancient. The area covered by the village cannot now be determined.

No. 88. A village 200 yards southwest of No. 87, on an adobe knoll, was observed. The scattered debris seems to indicate that it was a very large village. No general foundation walls now exist. Several Navajo fireplaces have been made on the site. One particular spot contains an immense amount of potsherd material, which probably marks a burial site or a crematory. The foundation walls of one narrow room, lying in a north-and-south direction, still remain. It was five paces long by two paces wide. It was probably a secret closet.

No. 89. Located 387 yards southwest of No. 88 is much scattered broken pottery and other debris, but it is the writer's opinion that it is the Navajos' work, as the pottery is unmarked.

No. 90. A part of the foundation walls of what appears to have been a large village still exist, about 50 yards southwest of No. 89. It is situated on a wind-swept adobe knoll. Broken metates and much broken pottery mark the site. Much of the ware is of the crinkled, corrugated type. There is also some red ware with black markings and white ware with similar black markings. Several broken metates were seen.

No. 91. This village site is about 400 yards southwest of No. 90 Much pottery, strips of foundation walls, grinding stones, etc , mark the spot. Part of a much-decayed skeleton shows.

No. 92. This is a ruin of a small village about 150 yards southwest of No. 91. It is situated on the south side of the same ridge. It has been much disturbed by Navajo encampments The remains of one very large hogan shows on the site, whose circular foundation walls were partly of stone and sixteen feet across. Two stone "fireplaces" also show. Much red pottery shows.

No. 93. The sand is being blown off of what appears to be the remains of a very large village about 600 yards northwest of No. 93. It is on a sand point. What appears have been walls of some of the rooms now show, and were at base partly of rock. Quantities of broken pottery are scattered about. A single house seems to have been built 100 yards to the eastward on the same knoll.

No. 94. (See "Lion Head group of ruins," plate 4, for 94-98.) Northeast of Twin Rocks, about a mile northeast of Black rock, is a small ruin site covered with much pottery. The Indian guide found an Indian axe there.

No. 95. A ruin a little northeast of Twin Rocks was observed. It was built on a sand knoll, which is now mostly blown away. The top of the knoll is capped with a large stone edifice, which appeared to be different from any ruin the writer had previously seen. It was circular and consisted of a single room about sixteen feet or less in diameter, apparently built in a somewhat igloo style. Its east and north walls are still intact. Much pottery is scattered about this edifice. As the ruin is circular, the writer at first took it for a stone hogan which had probably been constructed on the ruins of an ancient village, the rock of which it was built being from the stone of which the ancient ruin had been constructed. An objection was that no similarly constructed hogan of a Navajo had so far been seen by the writer, and he has never read of a hogan so constructed On examining it his Navajo guide stated that it was not a Navajo structure Our missionary, Rev. L. Segar, who was with the party, also stated that he had never seen a hogan thus constructed The shards which were scattered about, on the other hand, were distinctively of the Pueblo cliff-house type. The writer cannot help but come to the conclusion that if this structure belongs to the cliff-house dwellers it was built at a later period than the other ruins of the region.

Since the writer examined this ruin, in the spring of 1919, Kidder and Guernsey's report on "Archæological Explorations in Arizona" has been published [5] In this report, page 54, they described similar ruins to the one described above, being in the same valley, about five miles to the eastward. Below is a copy of their findings

"The ruins on the bench (opposite the mouth of Olla House, about eight miles below Kayenta) consists of thirty or more round or oval inclosures, scattered irregularly over the whole slope. The circles which vary from six to ten feet in diameter, are made of large slabs set on edge. Excavation showed that each house had a hard floor of packed adobe, seemingly without a regular fireplace. The wall slabs are sunk into the ground from five to eight inches below the floor. There do not seem to have been lateral doorways, the inclosure usually being unbroken. In some cases the rooms are partly sunk into the sidehill, making them semisubterranean. As there is practically no fallen building stone in or about them, we think it probable that their upper parts were of the same 'turtleback' adobe construction that was observed by us in similar round rooms with slab foundations at Fluteplayer House. (The bottoms of the walls are made of large, flat sandstone slabs set on edge in the earth, in the circular constructions in the vicinity of Fluteplayer House, and the building was carried up by means of adobe 'turtlebacks,' masses of clay averaging fifteen inches long, five inches wide and three and one-half inches thick, which were put on wet and pushed and flattened down over the series below. An occasional stone was introduced among the adobes. After the structure had dried and settled together the irregularities and cracks were filled and smoothed over with more clay, making a firm, enduring, good-looking wall.[6]) This view is further strengthened by the type of pottery found in the foot or so of sand, charcoal and ashes which covered the floor in each inclosure. It is exactly the same style—both black and white, and coarse black with broad, flat coils about the neck—as is found in Fluteplayer House. In the rooms themselves we found no Kayenta shards, and very few of them among the thousands of fragments that litter the surface of the bench."

Messrs. Kidder and Guernsey placed these ruins in what they designated as "slab-house culture" group, stating that the pottery found by them differs from the true Kayenta wares. They place the "slab houses" they examined

5. Loc. cit., pp. 54, 42, 43.
6. Loc. cit., p. 43.

as earlier than the true Kayenta ruins, as does Professor Cummings as to similar houses found near Segiotsosi (Segihotsosi). The structure examined by the writer seems to be younger in time than the true Kayenta structures; but before any definite opinion can be had, more of such ruins must be found and examined.

No. 96. This is Box-elder Cliff Cave, so named because the only box-elder trees in the region grow near it. This cliff cave is large and could have accommodated a large village, but the writer could find no evidence that one was ever there. It has been reported to the writer that Doctor Cummings found nothing in this cave when doing excavating work in that section years ago. The cave opens to the north on the north side of a large cliff, and it may be for this reason that it was never inhabited.

No. 97. This is the remains of a cliff house on the west side of the third bench of Lion Head rock. It was found by Missionary Leigh Segar and his interpreter, Charles. The rooms filled in an excavated shelf along a shaly layer between massive sandstone strata. It was once quite extensive, but now only a single room remains, and a part of its side wall is gone. This room has about a twelve-foot front A very small doorway still has the wooden crosspiece support above it in place.

No. 98. The site of this ruin abuts Lion Head rock on the southeast. The village is now wholly obliterated but for the scattered potsherds, which are all broken into small bits, seeming to indicate that the village is very old. Our Indian guide found a fine pottery dish six inches in diameter and four inches deep. It was under a large bowlder on the second bench of the rock point just above the village. The piece of pottery was entire. It had probably been placed there in some votive offering to their gods, probably containing some kind of pollen or sacred meal; and though hundreds of years have passed since the hand that placed it there was placed under the sand, it still sat intact and upright to our day. One curious thing connected with it is that this bowlder, on a sloping shelf near the edge of the cliff, though as large as an ordinary room in a house, should have been unmoved in these hundreds of years. Should it have moved, it would have broken the priceless dish.

Nos. 99a to 99h. These, as thus marked on the map, are as follows (see plate 4):

No. 99a. Signs of a ruin in scattered pottery show south of Three Mile Wash butte, but no village site shows. The butte referred to stands out in the flat as a detached part of Black mesa, some four miles southwest of Kayenta. A dry wash, a tributary of Three Mile wash, cuts across its southern front, and it is probable that this wash has carried away the village from which the scattered pottery came.

No. 99b. Part of the remains of a ruin is exposed one-half mile northwest of Three Mile Wash butte. It is on the west edge of a bluff overlooking Three Mile wash from the east. The main building was of stone, extending in a north-and-south direction twenty-one paces by probably twenty paces in width, the building collapsing inward. From it pottery extends forty paces southeastward and covers considerable of the slope toward the wash. A stone-enclosed Navajo grave, covered over with brush, mounts the pile of

rock of which the village was composed. No walls show. Some one has dug into this mound on the west side. The depth of the debris is about three and one-half feet in the part excavated.

No. 99c. A rock mound twenty-one paces in a north-and-south direction by about fifteen paces in an east-and-west direction marks the site of a village on the west edge of the above bench, one-half mile north of No. 99b, on the same side of the wash. Some pottery fragments show, but not enough to indicate that it was long occupied. A small Navajo altar occupies a site on its western margin.

No. 99d. The partial outline of a small village shows 378 yards northwest of No. 99c, on the same side of the creek. A Navajo has made a small altar on the site. But little pottery shows. A line of bowlders thirty feet to the westward served as "reserved" seats at their town gatherings (?).

No. 99e. A rock-mound ruin of a small building, probably the remains of a tower, is situated on a knoll across the wash 400 yards west of No. 99c. Some potsherds show. The edifice seems to have been circular.

No. 99f This is a ruin on the top of a butte on the same side of the wash as No. 99c, from which it is about one-fourth mile distant to the northward. The partial outline of a rock-walled room forty-six paces in circumference still shows, with a depressed center. It was probably a watchtower and kiva combined. But little pottery was seen.

Nos. 99g and 99h (Nos. 99f and 99g on the map.) These are two ruins on a sand knoll east of a long, north-and-south running, low mesa east of Three Mile wash. No walls show at either site, but much pottery is being uncovered by the wind No. 99g was a large village.

No. 99i. (No. 99h on the map.) This is a large ruin out in the flat about one-half mile east of No. 99g (on the map). The village was of adobe and is wholly obliterated. Much broken pottery marks the site

Ruins in the Vicinity of Chilchinbito.

About two miles north of Bitter Weed Water (Chilchinbito) trading post, twenty-three miles southeast of Kayento, a little to the east of the west road leading to the former place from the latter, a little pocket canyon leads eastward into a high cliff. The canyon is almost boxed, but is open at the head. In the shale along the north wall of the canyon are seeps and springs which supply a considerable amount of water. In the canyon, just east of the springs, are two clumps of apricot (peach) trees of mysterious origin. The mesa to the south of the springs is being covered over with shifting sand. In exposed patches beneath this sand there are village debris and an occasional wall foundation. The remains of a fireplace, which was probably in a kiva, also show. Much broken pottery, metates and manos are scattered about.

About a half a mile from this village there are several high buttes of sandstone. The south butte of the group is now inaccessible, though it once could be scaled from the northeast, and by the use of a ladder it could now be scaled. Its walls are fifty feet high. Its top cover about one-twelfth of an acre. There is every evidence that it was converted into a watchtower site or fort in the old times, as pottery and broken bread-preparing implements are scattered all about it, also many stones foreign to the butte. The principal

debris is at the northeast terminus of the butte, where the trail once led to its top. From this one would conclude that the main building was near this margin. The other buttes in the vicinity also show signs of having been village sites. Besides that, the whole front east of the buttes and extending northward toward the springs, and practically to them, is sprinkled with potsherds and other village debris, now showing here and there as the wind shifts the dune sand.

To the westward of the buttes is a large flat into which Spring canyon leads. This flat is a mile wide in places. It heads in several flat, radiating valleys in Black mesa adjacent to the southwestward It is now terribly cut by ravines, gullies and canyons. In this flat the remains of ancient irrigating ditches can be traced, especially one running in an east-and-west direction about one-fourth mile north of the buttes.

The evidence shows that a series of villages once occupied the upland adjacent to these buttes. The permanent water supply for the villages for house purposes was the springs. For protection, fortlike villages towered the buttes, the principal fort being on the southeast butte At that time the adjacent flats to the west were not cut with gutters and canyons as now, the cutting being prevented by careful use and storage of water. The flats were carefully irrigated and produced fine crops Now probably thirty acres are farmed by the Navajos. It then supported a population of at least 500 souls. The abandonment of these villages and the total destruction of the fine valley lands by erosion tell a sad tale

Conclusion.

From the data at hand, either a very numerous people lived here contemporaneously or a few people lived here a very long time. From the work of the Wetherils, Cummings, and Kidder and Guernsey,[7] it seems that we have three cultures represented in this region—slab house, basket maker, and cliff dweller, given in the order of their respective ages, according to those authorities According to the same authorities, the slab-house people built round lodges with stone slabs set in the ground edgewise for base of the structure, over which probable "turtleback" adobe-mud "brick" were placed to finish the structure, the roof probably being flattish-conical. The basket-maker people used no pottery, but only baskets. Their chief burial place was in the caves of Kinboko canyon southwest of ruin A. The third culture comprised the cliff dwellers in general, whose ruins dot the country in all directions and fill every nook and corner and crevice in the canyon walls. They also place stress on the pottery found in the first- and last-mentioned houses, the slab-house pottery being the coarser pottery. The ollas of this type of ruin are full and rather squatty in body, and in the corrugated ware the corrugations in many cases are flattened bands.

The writer has nothing to add to the above findings, except some remarks on the slab houses.[8] The ruin he examined seemed to be even as young as the latest cliff houses of the region, but he has not data enough at hand to verify such a conclusion. His Hopi (Oraibi) helper, Clarence Taptuka, also concludes that the circular buildings, designated as "slab houses," are tem-

7. See Kidder and Guernsey; loc. cit., pp. 200-212.

8. It may be found that the basket-maker culture was the culture of a basket society of the cliff-house village people.

porary kivas. He states that he has seen several of them used by his people in his own time, at the time of special ceremonies out from the village. According to his statement, the foundation of these structures is usually of slabs set edgewise in a circle, reinforced with adobe, which is also used to make the walls the proper thickness. From the base the edifice is often completed with poles set on end, extending from the base to the proper height, over which a wickerwork is woven, the same being plastered over with adobe both within and without. At other times other hurried devices are used. The "turtleback" walls of Kidder and Guernsey show that the structure was hurriedly built, as the "turtlebacks" had been dried only enough for handling before being placed on the walls, as they showed signs of mashing and pushing together on the walls while yet in the plastic state. This bears out Mr. Taptuka's belief that they were temporary structures. He also believes that the numerous individual circular slab-house ruins on the bench near Olla House, ruin 7, of Kidder and Guernsey, "represent the collecting together of a large assemblage of the cliff dwellers on this bench for some special occasion, and that for the occasion a temporary kiva was erected for each clan. He also accounts for the coarser pottery by the fact that only such pottery, the poorer kind in finish, was used for such purposes. On such occasions the better, most valuable pottery was left at home, as the stay was to be temporary and only such cooking utensils as were needed were taken to the place of encampment.

If Mr. Taptuka's conclusion is correct the slab-house structure may be found in any cliff-house stage of culture, and may be recent or remote in time. Later in this article the writer will have more to add concerning these so-called slab houses.

The writer desires to add that many of the smaller ruins of the region of the undisputed cliff-dwelling type may have been constructed somewhat in the manner in which the slab-houses were constructed, and this may account for the small amount of rock about such ruins. And again, many of the villages show that the west and southwest buildings, or walls, were of stone, while only scattered pottery (and possibly a low mound) represents the remainder of the edifice It seems, therefore, that the eastward-lying buildings of each village were of adobe structure or built of lattice work plastered over with adobe, as are some of the existing rooms at both Keetseel and Betatakin.

As to the undisputed cliff-dweller ruins and pueblos (ruins of the Kayenta culture) of the region, the evidence goes to show that the culture began with the small-house village type, the same as the peoples of Pine river valley, Colorado, described in this paper, and the small-house people of north central New Mexico, as described in *El Palacio* by Mr. Douglas.[9] Upon their coming into the region, or their development into a pueblo type in the region, they began the cultivation of the land and the use of water by irrigation. As they more thickly populated the region, more water was used. As a consequence, every side stream, every canyon, every spring had its village or villages depending upon it. Every bit of water was used. The washes had reservoir dams and check dams constructed in them to impound the water at every available site, as the writer has shown, and as was found at Marsh pass

9. Douglas, William Boone; The land of the small-house people: *El Palacio* for April, 1917; and The shrines of the small-house people: *ibid.*, July, 1917, pp. 19-29.

both by the writer and by Kidder and Guernsey.[1] As a result of this intensive use of the water from the washes, no water reached the master stream, which in the Kayenta section was Chinle creek, ultimately the San Juan. As a result, the valleys were aggraded, as we have seen. As the valley fillings mounted higher the villages were changed or rebuilt on the former debris, as is shown in many cases by cross-sectioning. Some of the villages that were buried are now being exposed in the canyon cutting, and so on. In time the outleading channels toward the master stream became filled up with detritis from the washes, which the weakened currents managed to carry to it, and also with wind-blown earth particles. Outwash, dry alluvial fans were also formed where the washes "dried up" on the flats. As a result of this damming on a large scale by natural processes, there was produced a ponded pool to laked stage. Under these conditions the house builders prospered, as there was water, in abundance for every use known to them. They increased in numbers till their villages and cliff places were more numerous in the area than are farmhouses in central Iowa. There are more than 200 known ruins in the area mapped, which probably does not represent more than one-fourth of the existing villages in that area. In the Laguna valley part, from Comb ridge to Black mesa and from Church rock to Marsh pass, there are 100 ruins now known, which probably does not represent half of the number, though the area described does not exceed fourteen miles in length by seven miles in width in the vicinity of Church rock, tapering to a point at the pass. Thus was the extent of the villages at the zenith of Kayenta power.

Then there came a withdrawal to larger centers, followed by the building of larger villages. One of these centers was evidently Moqui rock. Another lesser center was ruin 15c and the ruins in its vicinity. Then they apparently withdrew to the vicinity of Marsh pass and the Segi canyons, where the culture seems to have culminated, not once, but probably at different times, the final culmination being reached in the great cliff houses of the Segi canyon region.

Concerning this culture Kidder and Guernsey say:[2]

"To summarize. We have abundant remains, in the form of cliff-dwellings and surface ruins, of a fairly homogeneous culture occupying the whole region. It is characterized by stone houses built aboveground, specialized ceremonial rooms or kivas, and high development of pottery Corn, beans and squash were cultivated, cotton was grown, and the turkey was domesticated. The textile arts were well developed, particularly in loom weaving, twilled work (matting, baskets, cotton bags), and twined work (cord sandals). Very good coiled basketry was produced, but apparently in rather limited quantities. Stone implements, both polished and chipped, were not remarkable either for abundance or for excellent workmanship.

"All the cliff dwellings and pueblos examined were enough alike in architecture, kiva construction and pottery to warrant their being assigned to a single culture period. There are, however, differences between the pottery of some of the small settlements (ruins 2, 3, 4, 5 and 7), on the one hand, and a group consisting of small houses 6 and 8 and the pueblos of Marsh pass on the other, that seem to show a variation of some sort within the culture, and therefore point to a fairly extended period of occupancy. The wares of the former division lack in general features characteristic of high specialization (shapes such as the flat-topped ollas and colanders; intensively elaborated decorations, as 'underframework' in black and white; white-edged designs in polychrome)

1. Loc. cit., pp. 64, 65.
2. Loc. cit., pp. 200, 201.

which are found so commonly in the wares of the second group. This would seem to indicate that the ruins of the first group were somewhat earlier than those of the second, and also that they were of somewhat wider distribution; also that toward the end of the period of occupancy of that district the population withdrew to the vicinity of Marsh pass, where the culmination of the culture, so to speak, was reached in the pueblos of the pass and the great cliff houses of its tributary Segi canyon."

In a footnote on the last page mentioned they further add:

"This process—*i. e.*, early diffusion in small sites, later concentration in large centers with high cultural specialization, and lastly more or less abrupt abandonment of the whole regions—is a common phenomenon in southwestern archæology. Examples are: Chaco canyon, Mesaverde, Lower Gila, Casas Grandes. It has not yet been satisfactorily explained, though an attempt to account for it on the basis of climatic change has been made by Huntington (1914)."

Doctor Fewkes believed that the ruins of this region were made by the ancestors of the Horn, Snake and Flute clans of the Hopis of to-day.[3] Kidder and Guernsey call it Kayenta culture and leave it at that. Following Doctor Fewkes, it is the writer's opinion that a great part of the ruins are of villages made by the ancestors of the present Hopis, except that he believes they were made by practically the whole Hopi tribe proper, and not by two or three of their clans. The ruins which seem to have been made by them are too extensive and too numerous to have been made by a few representative clans of that people

Many glyphs on the rock walls are undoubtedly of Hopi maidens with their whorled hair, representing the pumpkin blossom of fertility.[4] My Hopi helper, Clarence Taptuka, and his wife's relatives also readily identify the glyphs on the rock walls near ruin 21 on Man's Head point to be the clan signs of the Snake, Spider and Rabbit clans of their people. A doll found in the cave northwest of the school (ruin 20) they readily identify as a kachina doll used in the bean dance ceremonies, also of their people. Ceremonial object No. 65 of Kidder and Guernsey[5] they identify as an ear pendant of their people, representing the spreading pumpkin blossom, used in the kachina dances and in the butterfly ceremonies. Also they readily identify the sunflowers and cones found by Kidder and Guernsey and the bird figured by them as paraphernalia used by their people

Mr. Taptuka states:

"The doll is used in the bean ceremonies at night, now had usually the night following Christmas. It is used in the initiation ceremony into the Bean Society, and is given to the novitiate the morning before the dance. The ceremony is secret. There are two degrees in this society. In the first degree the children wishing to join it are admitted into the kiva and are allowed to see the things of the gods that are collected for the ceremony. In the second degree there is a real initiation. On entering the kiva one is strapped by three people of ceremony. All three of the strappers are men, but one personates a woman and is so dressed. A Hopi is not considered a 'man' or a 'woman' till they have joined this society. The doll is used in the ceremonies of both degrees. After the ceremony the initiated used the dolls as play dolls."

3. Loc. cit., pp. 1-3, 24, 26, 34, 35.
4. See Kidder and Guernsey, loc. cit. pp. 90-94.
5. Loc. cit., p. 145.

He further states:

"The bird is used in the kachina dances. It is usually placed on some conspicuous place on the dancing mask. The cones are used to represent ears on the masks, also worn in certain kachina ceremonies (as Tacab [Tenebigji] is dressed on plate xxvi of the Twenty-first Annual Report of the Bureau of American Ethnology). Usually only one is worn on the mask, on the right side. False hair is then wrapped around this pretended ear and let fall over it in front so as to obscure it and the string attachments that hold it to the mask. This wearing of one ear on the mask is to illustrate a myth of the long ago, which states that a certain maiden, who was making her toilet, had one whorl of her hair done up to represent the pumpkin blossom, when she was attacked by an enemy, from which she escaped with her hair only half arranged.

"The sunflowers are used only in the bean dances They are used somewhat like a forehead star is sometimes used by white people. They are used in the initiating ceremonies into the order. The wearer is a man impersonating a woman, and is so dressed In the dance the women and men line up in the kiva facing each other, much like white people do in the Virginia Reel dance, the men occupying the right side of the room as one faces the banquet (visitors' place in the hall), the women the left. The men impersonating women line up with the women In the dance the two at the foot of the rows (the ends farthest from the banquet) step to the center of the room and clasp hands (like Powamû and So Wugti are clasping hands as shown on plate xiv of the above ethnological report) [6] They then dance forward to the front of the room to the sipapu hole in the floor in front of the fire pit. They then retrograde in a backward dancing movement to the starting point. Then again they dance forward to the sipapu hole in the kiva, after which they separate, each going to his or her respective side While this couple are thus dancing, the columns are dancing in a slight shuffle, side movement to the rear. As they thus dance the men wave rattles in their right hands and bunches of cedar twigs in the left, while the women wave longer cedar twigs in their left hands only. Also, as the respective partners come together for the central dance, the man gives his partner a 'hank' of corn bread baked in corn husks, so tied with yucca as to much resemble a white man's fancy necktie. This the lady accepts and thrusts into the bosom of her dress or within a fold of her blanket, provided she wears one. A 'set' lasts through the singing of a chanted song. Several sets are thus enacted Then the participants repair to a neighboring kiva and enact the same ceremony again. Thus they go from kiva to kiva and perform till the close of the night. The collected corn bread, which has been tasted now and then, is then eaten without the kiva of each respective clan."

While there seems to be abundant evidence that a great part of the villages and cliff houses now in ruins were made by the ancestors of the present Hopis, there also appears to be evidence that other peoples lived in the region as well. There also seems to be evidence of a partial or whole abandonment of the region by the cliff-village dwellers, and either the return of the same with a modified culture or the repeopling of the region wholly by a new people of an allied Pueblo stock. Moreover, some of the ruins appear to be very recent.

Granting or barring the belief that the basket-maker and slab-house people were the first village people in the region, the undisputed first cliff people of the true Pueblo type were from the northeast, from the Montezuma creek, McElmo and Mesaverde country. With their coming they brought their culture with them. One of their characteristic things was the "six-pilastered" kiva, like those of the Mesaverde, McElmo and Montezuma creek type farther to the north. Turkey House, just around the corner of the rock ledge

6. The parentheses are mine.

northeast of Keetseel, has such a kiva. The pottery of this ruin is also of an older type than that of its neighboring villages. Again, a great part of the kivas of the region are circular, which is not a Hopi type of kiva, theirs being rectangular with a simple front-place banquet. Moreover, the largest cliff villages, Keetseel and Betatakin, which it is believed are recent and were nearly if not actually contemporaneous, show directly opposite styles of kivas, as do many other ruins of the section. Betatakin has the rectangular kiva like the Hopis and the Jemez, and Keetseel the circular type like the San Felipe and Santa Anna Indians of New Mexico, some modified in detail.[7] It is evident that a different people occupied Keetseel from the people who lived at Betatakin, as much different from each other as the Jemez and San Felipe Indians of our day, the index of their dissimilarity in culture being shown in their kiva construction. Moreover, to leave the cliff ruins and go to the villages of the flats, some show evidence of extreme age Some villages are deeply buried beneath shifting sands. Others, in practically similar positions with respect to weather and wash, still show signs of walls above the surface. Of other villages of similar protection, the pottery of one is found in large pieces, of another the mound of the village is completely obliterated and the pottery is all broken into small bits Also, as we have seen, there are at least two styles of pottery—the pottery of the true Kayenta culture and that of the Turkey House type. The latter, with the six-pilastered kiva of that ruin, appear to be roughly contemporaneous with the Chaco canyon and Mesaverde periods; the former of a subsequent time.

Again there is evidence that certain ruins were built from material taken from other villages, which is evidence that the one set of villages superseded the others in time. As an example, ruins A and B have fragments from the ruin Tower House incorporated in their walls. Tower House, as we have seen, stands on a spur almost below ruin B Only a small portion of the northwestern wall of this once considerable structure now remains The double-faced, rubble-filled masonry was plastered within and smoothed without, as in ruin A. Some of the smooth-faced rocks with incised designs in the latter ruin seem to have been taken from this ruin, and undoubtedly blocks were taken from it and incorporated in ruin B. Concerning these incorporated incised rocks in this ruin Kidder and Guernsey say:[8]

"Built into the walls are several stones bearing incised designs (plate 19b, lower left-hand corner). That the decorations were cut on the stones before they were introduced into the masonry is shown by the fact that the adobe mortar runs over the designs in several instances. One block pictured in plate 20 is even more conclusive; it was broken in two and the halves were built into different courses of the wall."

The incised rocks were undoubtedly taken from the one ruin and built into the other. Moreover, the incorporating of the parts of the same slab into different parts of the wall show that the last builders had no idea of the designs depicted on the slab. Evidently the time elapsing between the building of the two villages was of long duration.

Concerning the stages of cliff and village building, most of the visitors to the region, including trained archæologists, are struck with the apparent re-

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7. See Kidder and Guernsey; loc. cit., p. 203.
8. Loc. cit., p. 58.

centness of some of the ruins, especially Keetseel and Betatakin. In appearance they seem to have been inhabited at no distant time. In fact, as one observer remarked to the writer, it seems, on looking on the magnificently preserved ruin of Keetseel, that the people who went on a feasting tour or left the village through fear yesterday should return to their adobe this evening. It is indeed a village of only yesterday. Yet notwithstanding the recentness in appearance of these villages, no civilized man, so far as can now be learned, has ever made mention of them till within a little over the last score of years. However, there seems to be evidence that well-preserved ruins were built within historic times.

Lieutenant Bell, Second United States Infantry, visited the region in 1869 and left his name on the walls of ruin A. A Spanish soldier (?), Ghos by name, visited Inscription House west of Betatakin and left his inscription thus: "Ghos, 1661 Ano." A Spanish sword was found in the northeast part of the Navajo country some years ago.

Professor Gregory mentions peach trees in the Navajo country, as follows: "Peach trees grow wild in Nazlini and de Chelly canyons, probably introduced by Spaniards."[9]

A peach grove also occurs at Chilchinbito springs and one in the Segi canyon region. Concerning the latter grove Doctor Fewkes says:[1]

"One of the most interesting discoveries in West canyon (west of Betatakin) is the grove of peach trees in the valley a short distance from the canyon wall. The existence of these trees indicates Spanish influence. Peach trees were introduced into the Hopi country and the Canyon de Chelly in historic times, either by Spanish priests or by refugees from the Rio Grande pueblos. They were observed in the Chelly canyon by Simpson in 1850."

Straw was also used in adobe in making brick in a ruin in West (Segi) canyon, which seems to show Spanish influence. The laying of the wall was hurriedly done.

Concerning these "brick" Doctor Fewkes says:[2]

"The ruins in West canyon (plate 2) are particularly interesting from the fact that the walls of some of the rooms are built of elongated cylinders of clay shaped like a Vienna loaf of bread (much like the 'turtlebacks' of Kidder and Guernsey).[3] These 'bricks' consist of a bundle of twigs enveloped in red clay, which forms a superficial covering, the 'brick' being flattened on two faces. These unusual adobes were laid like bricks, and so tenaciously were they held together by clay mortar that in one instance the corner of a room, on account of undermining, had fallen as a single mass. The use of straw-strengthened adobe blocks is unknown in the construction of other cliff houses, although the investigations at Cliff Palace in Mesaverde National Park revealed the use of cubical clay blocks not having a central core of twigs or sticks, and true adobes are found in the Chelly canyon and at Awatobi."

There seems also to be evidence that even the Navajos used the De Chelly cliff houses as places of defense since our occupation of the country. In one of the congressional publications (?) of about 1868 one of the generals who visited the region makes affidavit that the Navajos fired on his troops from cliff-house protections in the De Chelly region.[4]

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9. Water Supply Paper 380, p. 73.
1. Loc. cit., p. 5.
2. Loc. cit., pp. 4, 5.
3. Loc. cit., pp. 42, 43. The parentheses are the writer's.
4. The book containing this affidavit was in the Wetheril library at Kayenta in the summer of 1919, and was read by the writer there. Diligent search for the book, however, now both by him and by the Wetherils has so far failed to locate it.

Indian traditions also indicate that at least a great majority of the recent-looking ruins were made by the Pueblos since the coming of the Spaniards.

When at Jemez the Indians told the writer that both in 1694 and 1696, when they were defeated by the Spanish allies under De Vargas, the bulk of their people fled to the Navajo country, where they remained many years. They also stated that many of their people remained with the Navajos, while some Navajos returned with them on their return to their former homes, and still remain with them. Moreover, in going around the village of Jemez one can readily determine those of the former Navajo stock from the true Pueblo type, thus verifying the tradition.

Mrs. Lulu Wetheril, who has studied the Navajo customs for many years and who is now chairman of the Woman's Roosevelt Memorial Association for Arizona and museum assistant of the State University at Tucson, Ariz., told the writer that there were several Jemez clans among the Navajos, also several clans from other pueblos, and that each clan had its tradition concerning its being incorporated in the Navajo tribe as a unit, with full, equal privileges with the original Navajos.

Concerning these accessions to the Navajo tribe the Navajo Ethnological Dictionary says:[5]

"Strangely enough, some of the . accessions, such as the Jemez, Sia and Ute clans, coincide both in name and affiliation with the original clans adopted by the Navajos from these tribes. These are not regarded as captive clans, . . . as their relationship with all the other clans of the group is never disputed."

Concerning the relationship of the Jemez with the Navajos, and the Jemez finally fleeing to the Navajo country, Doctor Hodge says.[6]

"In the opinion of Bandelier it is probable that ten pueblos were inhabited by the tribe (Jemez) in the early part of the sixteenth century Doubtless the reason for the division of the tribe into so many lesser village communities, instead of aggregating in a single pueblo for defense against the persistent aggressiveness of the Navajos, according to Bandelier, was the fact that cultivable areas in the sandy valley of the Jemez and its lower tributaries are small and at somewhat considerable distances from one another; but another and perhaps even more significant reason was that the Navajos were apparently not troublesome to the Pueblos at the time of the Spanish conquest. On the establishment of Spanish missions in this section and the introduction of improved methods of utilizing the water for irrigation, however, the Jemez were induced to abandon their pueblos one by one, until about the year 1622 they became consolidated into the two settlements of Gyusiwa and probably Astialakwa, mainly through the efforts of Fra Martin de Arvide. These pueblos are supposed to have been the seats of the missions of San Diego and San Joseph, respectively, and both contained chapels, probably, from 1618. Astialakwa was permanently abandoned prior to the Pueblo revolt of 1680, but in the meantime another pueblo (probably Patoqua) seems to have been established, which became the mission of San Juan de los Jemez. About the middle of the seventeenth century the Jemez conspired with the Navajos against the Spaniards, but the outbreak plotted was repressed by the hanging of twenty-nine of the Jemez. A few years later the Jemez were again confederated with the Navajos and some Tigua against the Spaniards, but the contemplated rebellion was again quelled, the Navajos soon resuming their

5. An Ethnological Dictionary of the Navajo Language, by the San Franciscan Fathers of St. Michaels, Ariz., p. 426.

6. Hodge, Frederick Webb; Handbook of American Indians: Bull. 30, Bureau of Am. Ethnology, vol. 1, pp. 629, 630; Washington, 1911.

hostility toward the village dwellers. In the revolt of the Pueblos in August, 1680, the Jemez took a prominent part. They murdered the missionary at Gyusiwa (San Diego de Jemez), but the missionary at San Juan de los Jemez, with the *alcalde,* mayor and three soldiers, succeeded in escaping. In 1681, when Governor Otermin attempted to regain possession of New Mexico, the Jemez retreated to the mesas, but returned to their village on the evacuation of the region by the Spaniards. Here they probably remained until 1688, when Cruzate appeared, causing them to flee again to the heights. When Vargas came in 1692 the Jemez were found on the mesa in a large pueblo, but they were induced to descend and to promise the Spaniards their support. The Jemez, however, failed to keep their word, but waged war during 1693 and 1694 against their Keresan neighbors on account of their fidelity to the Spaniards. Vargas returned to Jemez in 1693, when they reiterated their false promises. In July, 1694, he again went to Jemez with 120 Spaniards and some Indian allies from Santa Ana and Sia. The mesa was stormed, and after a desperate engagement, in which eighty-four natives were killed, the pueblo was captured. In the month following, Vargas (after destroying this village, another on a mesa some distance below, and one built by their Santo Domingo allies three leagues north) returned to Santa Fe with 361 prisoners and a large quantity of stores. From this time on the only then existing pueblo of the Jemez reoccupied was San Diego, or Gyusiwa, which was inhabited until 1696, when the second revolt occurred, the Indians killing their missionary and again fleeing to the mesas, where they constructed temporary shelters. Here they were joined by some Navajos, Zuni and Acoma allies and made hostile demonstrations toward the Sia, Santa Ana and San Felipe people, but in June of the year mentioned they were repulsed by a small detachment of Spaniards from Bernalillo and Sia with a loss of thirty men, eight of whom were Acoma. The defeated Jemez this time fled to the Navajo country, where they remained several years, finally returning to their former home and constructing the present village, called by them Walatoa, 'Village of the Bear.'"

Also concerning the same movements *El Palacio* states [7]

"In 1646 the Spaniards hanged twenty-nine of the Jemez Indians for conspiracy with the Navajos. At the outbreak of the Pueblo rebellion of 1680 Jemez killed one of its two Franciscan missionaries, Fra Juan de Jesus. In 1694 the Pueblos of Jemez were defeated in a pitched battle by De Vargas, the Indians losing 84 killed and 361 prisoners, and their two towns were burned. In 1696 the Jemez people again rebelled and killed their missionary, Fra Francisco de Jesus Maria Casanes. They were defeated in San Diego canyon with a loss of 30 killed, including 8 Pueblo allies from Acoma. The Jemez fled to the Navajo country. By 1709 they had built the present pueblo."

Again, concerning the Navajo tribe's growth, Doctor Hodge says.[8]

"Some of the accessions were evidently of Athapascan origin, as is most of the tribe, but others were derived from different stocks, including Keresan, Shoshonean, Tañoan, Yuman and Aryan; consequently, the Navajos are a very composite people. A notable accession was made to their numbers, probably in the sixteenth century, when the Thkhapaha-dinnay joined them. These were people of another linguistic stock—Hodge says 'doubtless Tañoan' —for they wrought a change in the Navajo language. A later very numerous accession of several clans came from the Pacific coast; these were Athapascan. Some of the various clans joined the Navajos willingly, others are the descendants of captives."

The Tañoan family included the Towa, Taño, Tigua, Jemez and the Piro group of Indians, and, according to the above by Hodge, it was accessions from this family that caused the change in the language of the Navajo from that of the pure Apache.

7. Mission churches in New Mexico: El Palacio, August 25, 1918, pp. 120, 121.
8. Loc. cit., vol. 2, p. 42.

That Pueblos have migrated to the country of the Hopi-Navajo is undoubted. Among these are the Hano of the Moqui. Hodge mentions these Indians and their coming to the Moqui (Hopi) country, as follows:[9]

"Hano (contracted from Anopi, 'eastern people'· Fewkes). The easternmost pueblo of Tusayan, northeast Arizona, and familiarly spoken of as one of the Hopi villages. It is, however, occupied by Tewa people, whose ancestors, early in the eighteenth century, migrated from the upper Rio Grande, in New Mexico, principally from an ancient pueblo known as Tsawarii, above the present town of Santa Cruz, where the hamlet of La Puebla now stands."

Also during the troubled times the Picuris and a part of the Taos fled to the Jicarilla Apaches at El Quartelejo, in Beaver creek valley, Scott county, Kansas; the ruin of their village there being excavated by Williston and Martin in 1900. The site is 350 leagues (1,210 miles) northeast of Santa Fe.[1]

"The Sandias, near Bernalillo, N. Mex, abandoned their pueblo during the Pueblo revolt of 1680, most of the inhabitants fleeing for safety to the Hopi country in northeastern Arizona, where, probably with other refugees, they built the village of Payupki, on the Middle mesa, the walls of which are still partly standing Payupki is the name by which the Sandia pueblo is still known to the Hopis. In 1681 Governor Otermin, during his attempt to reconquer New Mexico, burned Sandia The people remained among the Hopis till 1742, when Fathers Delgado and Pino brought 441 of them and their children to the Rio Grande, but it would seem that some of these returned to Arizona, since Father Juan Miguel Menchero, in a petition to the governor in 1748, stated that for six years he had been engaged in missionary work among the Indians, and had 'converted and gained more than 350 souls from here to the Puerco river, which I have brought from the Moqui pueblos, bringing with me the cacique of these Moqui pueblos, for the purpose of establishing their pueblo at the place called Sandia'"[2]

In Mr. Hodge's write-up on the Hopis[3] he gives more facts concerning migrations to the Hopi country He says in part.

"The pueblos of Walpi, Mishongnovi, and Shongopovi, situated in the foothills, were probably abandoned about the time of the Pueblo rebellion, and new villages built on the adjacent mesas for the purpose of defense against the Spaniards, whose vengeance was needlessly feared. The reconquest of the New Mexican pueblos led many of their inhabitants to seek protection among the Hopi toward the close of the seventeenth century. Some of these built the pueblo of Payupki, on Middle mesa, but were taken back and settled at Sandia about the middle of the eighteenth century About 1700, Hano was established on East mesa, near Walpi, by Tewa from near Abiquiu, N. Mex., who came on the invitation of the Walpians. . . . Two other pueblos—Sichomovi, on First mesa, built by the Asa clans (q. v) from the Rio Grande; and Shipaulovi, founded by a colony from Shongopovi, on Second or Middle mesa—are both of comparatively modern origin, having been established about the middle of the eighteenth century, or about the time the Payupki people returned to their old home.

. . . .

"The Honau (Bear) clan is represented on each messa and is supposed to be the oldest in Tusayan. It is said to have come originally from the Rio Grande valley. . . . The Kohop (Wood) phratry came from Siskyatki and have a

9. Loc cit, vol 1, p 531

1. See Hodge; loc. cit. p 245, in account of the "Picuris."

2. Hodge; loc. cit., vol. 2, pp. 429, 430.

3 Loc. Cit, vol. 1, pp. 561-564.

few representatives in Walpi and in the other villages. The traditional home of the Kokop and allied clans was Jemez (q. v.), in New Mexico. . . . The Asa people were Tewa in kin, coming originally from the Rio Grande valley and settling successively at Zuñi and in Canyon de Chelly."

Again when taking up the archæology of the Hopi country, he says:

"Sikyati, another large and well known ruin, in the foothills of the East mesa, was occupied in prehistoric times by Kokop clans of Keresan people from the Rio Grande country. They had attained a highly artistic development, as exhibited by their pottery, which is probably the finest ware ever manufactured by Indians north of Mexico.

"Payupki, a picturesque ruin on Middle mesa, was settled by Tanoan people (apparently Tigua) about the year 1700 and abandoned about 1742, when the inhabitants were taken back to the Rio Grande and settled at Scandia.

"Some of the most important ruins in the Hopi country are situated on the rim of Antelope mesa, not far from Awatobi, and are the remains of Keresan pueblos. Among these are Kawaika and Chakpahu In the same neighborhood are the ruins of Kokopi, once occupied by the Wood clan, originally from Jemez."

In writing about the Tanoan, he also states [4]

"The (Tano) tribe was almost entirely broken up by the Pueblo revolts of 1680-'96, the Indians removing mainly to the Hopis of Arizona after 1694, and the last tribal remnant in New Mexico dying from smallpox early in the nineteenth century."

Also, in speaking of the clans of the Laguna Indians, he states [5]

"According to Laguna traditions, the Bear, Eagle, Water, Turkey and Corn clans, together with some members of the Coyote clan, came originally from Acoma; the Badger, Parrot, Chaparralcock and Antelope clans, and some members of the Coyote clan, came from Zuñi; the Sun people originated probably in San Felipe; the Water Snake in Sia; the Rattlesnake probably in Oraibi; the Wolf and Turquoise in Sandia; the Earth clan in Jemez; the Mountain Lion and Oak people claim to have come from Mt Taylor; the Lizard clan is of unknown origin. Laguna, therefore, is not only the most recent of the New Mexican pueblos, but its inhabitants are of mixed origin, being composed of at least four linguistic stocks—Keresan, Tañoan, Shoshonean, and Zuñian."

"The original settlers (of Walpi) were the Bear people, who are represented to have come from Jemez. These colonists were later joined by the Snake and Horn peoples, whose ancestors lived in extreme northern Arizona. The Kachina clan came from the east; the Reed people are descendants of women captured at a Hopi town, now a ruin, called Awatobi. The Kokop clan came from Jemez, and made Walpi their home after the fall of their own pueblo, Sikyatki, in prehistoric times. The Patki, Kuhuch, and Piba-Tabo originally came from the south, where ruins of their pueblos are still visible at Winslow and near Hardy, Ariz., on Little Colorado river. The Flute people came from northern Arizona, where they once lived with the Horn and Snake clans. The Asa migrated from Zuñi. The sociological history and growth of Walpi are as follows. (1) Formed by Bear clans; (2) increased by accession of Snake clans; (3) enlarged by clans after the overthrow of Sisyatki; (4) destruction of Awatobi and assimilation of many clans therefrom; (5) advent of clans from the Little Colorado; (6) advent of Asa clans from Zuñi; (7) advent of the Tewa clans, some of whose descendants now live in Hano."[6]

4. Loc. cit., vol. 2, p. 686.
5. Loc. cit., vol. 1, p. 752.
6. Hodge; loc. cit., vol. 2, p. 902.

Also concerning the movements of the San Cristobal, Doctor Hodge writes:[7]

"The natives of this pueblo (San Cristobal) and of San Lazaro were forced by hostilities of the Apaches, the eastern Keresan tribes and the Pecos to transfer their pueblos to the vicinity of San Juan, where the towns were built under the same names. . . . This removal (which was more strictly to a place called Pueblito, near the present Potrero, about two miles east of Santa Cruz on the Rio Santa Cruz) occurred after the Pueblo revolt of 1680 and prior to 1692, at which later date the natives were found by Vargas in their new locality. The pueblo was abandoned in 1694, but was later reoccupied, and was finally deserted in 1696 after the murder of their missionary in June of that year. Most of their descendants are now among the Hopi of Arizona."

It is also written concerning the ruined pueblo of Tsawarii: "According to Tigua informants, it was once occupied by some of their people who went to live with the Hopi."[8]

It is also stated that Tisama, of Laguna, near the Indian village of that name, was so named because, it is said, some Sia once lived there.

That the Asa clans of Hopi not only once lived on the Rio Grande, but built villages at Canyon de Chelly, is attested by Hodge, as follows:[9]

"In the early days this people (the Asa clans) lived near Abiquiu, in the Chama river region of New Mexico, at a village called Kaekibi, and stopped successively at the pueblos of Santo Domingo, Laguna, Acoma and Zuñi before reaching Tusayan, some of their families remaining at each of these pueblos, except Acoma. At Zuñi their descendants form the Aiyaho clan. On reaching Tusayan the Posiwu, Puchkohu and Pisha clans settled with the Hopi Badger clan at Awatobi, the remainder of the group continuing to and settling first at Coyote spring near the east side of Walpi mesa, under the gap, and afterwards on the mesa at the site of modern Hano. This village the Asa afterwards abandoned on account of drought and disease, and went to Canyon de Chelly, about seventy miles northeast of Walpi, in the territory of the Navajos, to which tribe many of their women were given, whose descendants constitute a numerous clan known among the Navajos, as Kinaani (High-standing House). Here the Asa lost their language, and here they planted peach trees in the lowlands; but a quarrel with the Navajos caused their return to Hano, at which pueblo the Tewa, from the Rio Grande, in the meantime had settled. This was probably between 1700 and 1710. The Asa were taken to Walpi and given a strip of ground on the east edge of the mesa, where they constructed their dwellings, but a number of them afterwards removed with the Lizard and Bear people to Sichumovi."

In verification of the above Doctor Hodge also gives the following in another section of the above-cited book (p. 306)

"A well-authenticated tradition exists among the Hopi that about the middle of the eighteenth century a group of their clans, the Asa people, deserted their village on account of an epidemic and removed to Canyon de Chelly, where they occupied the cliff shelters for a considerable period, intermarrying with the Navajos."

It is written of the dance fraternity known as Kachina:[1]

"Kachina: The sacred dancing phratry of the Hopi, comprising the Kachina, Gyazru (Paroquet), Angwusi (Raven), Sikyachi (Yellow Bird),

7. Loc. cit., vol. 2, p. 428.
8. See Tsawarii: Handbook of American Indians, vol. 2, p. 822.
9. Loc. cit., vol. 1, pp. 99, 100.
1. Hodge; loc. cit., vol. 1, p. 638.

Tawamama (Blackbird), Salabi (Spruce), and Suhubi (Cottonwood) clans. They claim to have come from the Rio Grande, but lived for some time near the now ruined pueblo of Sikyatki."

During the troubled times in 1697-1703 rebel Queres from Santo Domingo, Cieneguilla and Cochiti fled westward and built the pueblo of Cubero, fourteen miles north of Acoma.[2]

Concerning the ruin of Kokopki Hodge says:[3]

"Kokopki (Hopi: 'house of the Firewood people'). A large, ancient, ruined pueblo, attributed by the Hopi to the Firewood clan, originally a Jemez people; situated on a low mesa, near Maupin's store, at Mormon John's spring, in Jeditoh valley, two and one-half miles east of Keam's Canyon school."

According to the above, this village was a Jemez pueblo.

Payupki was a pueblo, settled by Rio Grande Indians. Hodge says concerning it:[4]

"It is a ruined pueblo on a point of Middle mesa, six miles north of Mishongnovi, northeast Arizona. It was built and occupied by discontented Tanos, Tewa and Tigua from the Rio Grande, who left their homes between the Pueblo rebellion of 1680 and 1696. In 1706 the Payupki villagers were attacked and defeated by captain Holguin, who in turn was driven by the Hopi from their territory. In 1742 Padres Delgoda and Pino visited the Hopi country and returned to the Rio Grande with 441 Indians, said to have been Tigua, originally from Sandia and Alameda, and established them in the refounded pueblo of Sandia, to which village the Hopi still apply the name Payupki."

Most of these great movements were during the troubled times of 1680-1703, but there were other troubled times between the peoples of the region, and the Spaniards, almost if not as extensive as that of 1680.

When Coronado and his array of helmets and bright, shining armor came into the region of the village peoples there was a scattering of these simple folk, much like the fluttering efforts of a bunch of chickens to get away from a coyote who has suddenly got into the hennery. A summary of these troubled times in the Rio Grande region reads:[5]

"The Spaniards were received by them (the Tigua) with friendliness, but when it was decided to spend the winter of 1540-'41 in Tiguex province (at Bernalillo on the Rio Grande), and the Spaniards demanded of the natives 'about 300 or more pieces of cloth' with which to clothe the army, even stripping the cloaks and blankets from their backs, the Indians avenged this and other outrages by running off the Spanish horse herd, of which they killed a large number, and fortifying themselves in one of their pueblos. This the Spaniards attacked, and after exchanging signs of peace the Indians put down their arms and were pardoned. Nevertheless, through some misunderstanding the Spaniards proceeded to burn at the stake 200 of the captives, of whom about half were shot down in an attempt to escape the torture to which the others were being subjected. Says Castañeda, the principal chronicler of the expedition: 'Not a man of them remained alive, unless it was some who remained hidden in the village and escaped that night to spread throughout the country the news that the strangers did not respect the peace they had made.' As a result of this ill treatment the Tigua abandoned all but

2. See Hodge; loc cit., vol. 1, p. 369.
3. Loc. cit., vol. 1, p. 723.
4. Loc. cit., vol 2, p. 218.
5. Handbook of American Indians, vol. 2, p. 748.

two of their villages, one of which was also known to the Spaniards as Tiguex, . . ., into which they took all their stores and equipped themselves for the inevitable siege. Every overture made by the Spaniards was received with derision by the natives, who informed them that they 'did not wish to trust themselves to people who had no regard for friendship or their own word which they had pledged.' One of the Tigua villages was surrounded and attacked by means of ladders, but time and again the Spaniards were beaten off, fifty being wounded in the first assault. During the siege, which lasted fifty days, the Indians lost 200 of their number and surrendered 100 women and children. Finally the water supply of the natives became exhausted, and in an attempt to leave the village at night and cross the river with the remainder of their women, 'there were few who escaped being killed or wounded.' The other pueblo suffered the same fate, but its inhabitants apparently did not withstand the siege so long. In attempting to escape the Spaniards pursued 'and killed large numbers of them' The soldiers then plundered the town and captured about 100 women and children."

Castañeda continues by stating that the remaining Indians fled to the mountains and could not be induced to return till the army left the region for Pecos, and on the return of the army they fled again The same is his statement of practically every place they went. The Zuñi fled to Thunder mountain. The Hopis fled at the coming of the men with the fiery-mouthed, four-legged beasts, as the Indians termed the horses—and so on The statement says "the Rio Grande Indians fled to the mountains," but does not say where they fled; and, of course, there is no way of knowing whether the bulk of them ever returned, as it was forty years before another white man, Chamuscado, with eight soldiers, visited the region, and it was not till about 1629 that any real permanent settlement was made among them, at which time it was found that the earlier explorers had greatly "exaggerated" the population.

At several times between Coronado's time and 1680 there were troubled times, and each time the record reads "The Indians fled to the mountains." As the Teya and the Apaches of the east were generally hostile to the Pueblos, and the Athapascans of the west were, on the whole, friendly in those early times, practically every time there was a disturbance the Pueblos fled westward and northwestward The same was also probably true at least just prior to the advent of the white man. From the information obtained by Coronado, the Pueblo Indian enemies of that time were the Indians of the foothill-plains region. His expedition found the ruins of many villages between Bernalillo (Tiguex) and Pecos, also some villages where only a remnant were left as occupants. The Pecos advised him that these villages had just recently been overwhelmed by raids of the more savage tribes to the southeastward. At the time of these troubles in the Rio Grande-Pecos region the eastern Pueblos would flee westward for safety. Then when things would return to normal again all or a part of them would probably return.

Being Pueblos, they built pueblos in the places where they fled to in these trouble-upheavals. Sometimes the refugees from several different allied villages would together build the new village. Also at times even Pueblos of different linguistic families would join in building a common village. This, by the way, would lead to a change in the pottery design, etc., with a probable improvement of the same.

Thus did the Pueblos flee westward time after time and build villages, which they in time abandoned to return to their former homes. But all did

not return. Some remained with the Hopi, some with the Zuñi, some with the Acoma and Laguna, still retaining their Pueblo customs, modified in a measure by the customs of the peoples with whom they became amalgamated. Others became a part of the Navajo tribe, and though they were in such numbers that their incorporated words in the Navajo tongue have characteristically modified that language in a very noticeable degree, their identity, except a broken-down clan organization, has been wholly obliterated.

These comings and goings to the Navajo country and a staying of a part of those who came have resulted as follows: Both in protected places in the Navajo country and along the eastern margin of same are ruins of extensive villages which were constructed by these fleeing people from time to time, the more recent ones appearing as though they were abandoned only yesterday, so to speak. In addition, there are the remains of places of habitation and potsherds of the fragments of tribes that voluntarily remained with the Navajos and finally became amalgamated with that tribe. Moreover, their customs were deteriorating in their decline from the complex Pueblo type to that of the savage. In this change the pottery deteriorated in make from the specialized types of the village people to the very crude type of black ware of the Navajo. As a result pottery in all stages between the two would be expected to be found, and the same has been found in the so-called slab-house culture. And again, these incorporated peoples changed their places of dwelling from the pueblo type to the hogan, and one would expect to find lodges grading from the one toward the other, and this we do find in the slab-house structure. While still a house structure, the slab house was neither a pueblo nor a hogan, but a step between the two; and at that, possibly a hurriedly built, temporary abode—a foundation of rock, set on edge, was plastered over and built on with adobe (often plastered over a wickerwork frame) to complete the structure. The steps seem to be these: (1) A type pueblo; (2) a poorly constructed pueblo; (3) a hurriedly built structure, composed of "turtleback" brick; (4) the circular slab house; and (5) the hogan. Who can say but what the Navajo hogan is a combination of the Apache style of brush or flag structure and the Pueblo roundhouse (kiva) structure. (Also, in the development of the original Pueblo culture, provided it developed in the region, one would find the reverse—the development from the simple structure to the complex pueblo; and there seems to be evidence in places that such was also developed in the region.)

As these comings of the Pueblo peoples to the Navajo country and a portion of them remaining and becoming a volunteer part of the Navajo tribe seems to have occurred time after time, one would expect to find the gradation of culture from the village to the hogan repeated in varying form time after time; and such seems to be the case, though more data will be required to make sure of this point. It might be well to add here also that some of the refugee Pueblos might also have aligned themselves with the Piute and Utes and been absorbed by them. We might, therefore, find retrograde gradations between the true Pueblo and the Ute and Piute cultures.

The culture, as it is now understood, appears to have originated in the San Juan country, somewhere in the region where Utah, Colorado, New Mexico and Arizona meet, extending southward and eastward. At this time the villages were more or less of the small-house type, much like those of the Pecos people just prior to the coming of the Spaniards.

In writing of the Pecos Doctor Hodge mentions this phase of their habitation thus:[6]

"In prehistoric times the Pecos people occupied numerous pueblos containing from 200 to 300 rooms each, and many compactly built, single-story house groups of from ten to fifty rooms each. These were scattered along the valley from the north end of Canyon de Pecos grant to Anton Chico—a distance of forty miles."

In the same manner did the village people for a long period of time. Thus far and wide they pushed their possessions till they controlled a vast country. They were in undisputed possession and had no fear of enemies, else they would not have built their villages of the small-house type, and would not have built them in the open, exposed places as they did. Like ourselves, they felt secure. The ruins of that far-off time are now known as the villages of the small-house people, just as our own countrysides may be designated as houses of the single-house people by the archæologists 2,000 years hence. Conditions are such that we now feel secure in our one-family house; if they were not we would flock to centers for protection against a common foe. They felt secure in their small-house villages. Then there came troublous times. To meet the crises the villagers flocked to the cliffs or built those massive pueblo structures that are a wonder in our day, as did the Pecos just before the coming of the Spaniards. At this time the Pueblo culture seems to have reached its highest stage of perfection in the mesaverde region and in the Montezuma, McElmo and Segi canyons and in the regions about Canyon de Chelly and neighboring canyons. The six-pilastered kiva of Turkey House in Segi canyon shows that the culture came from the northeast to that canyon. Then the Pueblos were driven out of the region. The enemy—probably the Athapascans, Utes and Piutes—came from the west and northwest. Before them many of the Pueblos fled to the region of the Rio Grande - Pecos country. Others went southward. The Hopis tenaciously held fast to each inch of ground till they were compelled to leave it. They then retreated no further than they had to. At the coming of the Spaniards they were being driven out of Moenkopi by the northern savages. For 250 years in historic times they continued the struggle; and but for the aid of the white man, as is well known, the Navajo would have their beautiful fields under his ruthless heel there to-day, and the region where 300 Hopi now possess a fine village would be a desert.

Then after the Pueblos had all left the region of their ancestral home, like all peoples without records, this home passed into a myth. Moreover, the Grand canyon, that for ages, through the supposed will of their gods, was the barrier on the west and north between their lovely land of plenty and happiness and the wilderness of the savages on the other side, became the mythical "lagoon," the sipapu from which they believed they all originated and to which they expect to return at the close of this life. When we meet a stranger we often ask him, "Where did you come from?" The Indian is even more pointed with this question. To this question every Pueblo replied, "From the unfathomable hole in the earth" (the Grand canyon). Hence in passing into myth it became the hole (sipapu) through which the mythical first people came up from the mythical earth shelf below. To commemorate

6. Loc. cit., vol. 2, p. 220.

this event and to keep it ever in mind, the sipapu hole—a small, round hole—is usually made in the floor near the center or near one end of each kiva, or in a slab of cottonwood similarly placed in the edifice, as a medium of communication with the underworld. The lagoon that they mention as sipapu, therefore, would appear to be the Grand canyon passed into myth. My Hopi helper, Clarence Taptuka, advises me that his people consider this canyon their sipapu This would also point to a common origin of all the Pueblos, and also that their ancestral home was on the banks of that great chasm.

In the going and coming years after the great migrations, after a long lapse of time there arose troubles in the new homes and they were driven back or fled back through fear to their old homes, where the attitude of a former enemy had changed for a time. There they again made their homes till they were again driven out or became amalgamated with the more savage tribes of the region. Each time they returned they built a new set of villages. Two of the greatest of these westward migrations were probably in historic times—one at the time the Pueblos fled from the blazing armored men of Coronado, the other during the troubled times of 1680-1705. It is, moreover, quite possible that the recent-looking ruins, such as Keetseel and Betatakin in the Segi and a great part of the well-preserved ruins in De Chelly, Chaco and Del Muerto canyons, were built at this time.

In speaking of the ruins in Segi canyon Doctor Fewkes says [7] "The writer does not regard these ruins of great antiquity; some of the evidence indicates they are of a later time" He continues "Many of the ruins in Canyon de Chelly, situated east of Laguna creek, show marked evidence of being modern."

Concerning the modern appearance of certain ruins Hodge also says.[8] "That many of them (the cliff houses) were occupied in comparatively recent times is apparent from their excellent state of preservation"

The Jemez went to the Navajo country, so the Indian myths and Spanish records state. The records also state that at a later date the Spanish priests brought them back and they built their present village of Walatoa; but so far as the writer can learn, no record states to what part of the Navajo country they went. Betatakin has the appearance of a Jemez ruin and Keetseel that of a Santo Domingo village, and the kivas somewhat resemble those of these two respective villages, as now in use. That these two villages (Keetseel and Betatakin) are later in time than Turkey House near Keetseel is conceded by all the archæologists who have examined them. More data and a careful comparison of the pottery of these villages with the pottery of Gyusiwa at Jemez and the pottery of other eastern seventeenth-century villages of the Rio Grande region may throw some light on this subject.

The proof, beyond doubt, that a considerable part of the Tañoan Pueblos, to which stock the Jemez belong, voluntarily joined the Navajo nation, as probably did a minor number of the other Pueblo stocks, may also throw some light on why the Pueblo population has so diminished in numbers and the Navajo made such a rapid increase. Lesser accessions, besides the numerous captives, may also have been added to the various Apache bands in the same manner.

Thus in historic times, according to the Spanish records, and in prehistoric times, according to Indian myths, the Athapascan family and also the Ute

7. Loc. cit., p. 34.
8. Loc. cit., vol. 1, p. 309.

family of Indians were being increased in numbers at the expense of the Pueblos. Farther back in time, when the Pueblos were at the zenith of their power, the opposite was probably true. It was probably the incorporation of large bodies of people from other tribes in their different divisions that caused the three distinct Pueblo languages of our day, the same as the incorporating of a large Tañoan stock with the Navajo has changed the latter's language, as all ethnologists recognize.

That the Pueblos left the region through compulsion or fear seems very clear to the writer, though he realizes that this is contrary to the accepted theory.

Kidder and Guernsey suggest that their leaving the region was possibly due to climatic change, stating.[9]

"It has not been fully explained, though an attempt to account for it on the basis of climatic change has been made by Huntington (1914)."

Doctor Fewkes sums up his opinion in these words [1]

"The cliff dwellings were constructed partly for defense, but mainly for the shelter afforded by the overhanging cliff, and the cause of their desertion was not due so much to predatory enemies as failure of crops or the disappearance of the water supply."

But Hodge seems to be inclined to the other theory. In writing of the cliff dwellers he says [2]

"It is commonly believed that the agricultural tribes of pre-Spanish times, who built large towns and developed an extensive irrigation system, resorted to the cliffs, not from choice, but because of the encroachments of warlike tribes, who were probably nonagricultural, having no well-established place of abode. This must be true to some extent, for no people, unless urged by dire necessity, would resort to fastnesses in remote canyon walls or to the margins of barren and almost inaccessible plateaus and there establish their dwellings at enormous cost of time and labor; and it is equally certain that a people once forced to these retreats would, when the stress was removed, descend to the lowlands to reestablish their houses where water was convenient and in the immediate vicinity of arable lands"

Again touching on this subject when discussing the Pueblos, he writes:[3]

"These are the cliff dwellings built and occupied by the ancestors of the present Pueblos, no doubt for purposes of defense against ancient enemies."

In the writer's opinion, there is no evidence that the cliff dwellers and Pueblos left this region on account of climatic change and the lack of water. On the contrary, from the coming of the cliff dwellers to this region to our own time the climate has remained practically the same. Had there have been any radical change, sufficient to drive even man from the region, it would show in the flora and fauna of the country. The remains of the plants and animals found in the ruins are the same as species now living in the region. If the country had become such a desert that man could not live in it, the plants and animals of the predesert time would have succumbed as well as man; but such is not the case. The hills, buttes and mesas are covered with the same

9. Loc. cit, 201*n*.
1. Loc. cit., p 84.
2. Loc. cit., vol. 1, p. 306.
3. Loc. cit., vol. 2, p. 320.

plants now as in that far-off time; the same animals roamed the region then as when the white man came, and the same birds flitted through the air. Moreover, the geological and archæological evidence both show that through intensive irrigation produced by these people check dams were constructed in all the washes, and reservoirs were built at every possible place for the purpose of retarding the water flow and impounding it for village use and for the irrigation of their fields. The evidence also shows that through this careful use of the water the washes and master stream of the region became plugged with wind-blown earth and outwash material from the diminished, weak outflow of the mountain streams, due to the intensive impounding water system. As a result the valley floors were aggraded and pools of shallow lakes were formed along their courses. By this aggrading of the valley floors and the resultant ponded, laked stage, all the precipitation of the region was retained for the use of the cliff-dweller people; and this laked, ponded condition continued on down through the ages to our own time. But when the climatic conditions had reached the most favorable stage for the habitation of man, as there is ample evidence, the villagers left the region. Moreover, if they were compelled to leave the region on account of continued drought and lack of water, as is alleged, how could the Hopi, in a much drier section of the country, less than sixty miles distant, survive to our own time. It does not seem reasonable that the one could have survived to the number of 2,500 people and the other, in a more favored region as to climate and water supply, should have been wholly driven out by drouth. Another cause must be sought.

There is also ample evidence, it seems, that the Hopi were at least a part of the former people of this region, and it does not look reasonable that they would leave the beautiful valley of Laguna creek and the canyons of the Segi with their ponds and lakes for the sandblown region of the Hopi country of our day except through duress at the hands of a numerous enemy. Moreover, the concentration of the small-house peoples into huge communal edifices just before the abandonment of the region shows beyond doubt that they were harassed by such a people.

Again, the pueblos that have been abandoned in our own time have not been abandoned on account of climatic conditions, but through fear of attack, provided they were not overwhelmed by an enemy before they had a chance to escape.

The Quercho in the sixteenth century and the Comanche in the seventeenth and eighteenth centuries, in raids, so reduced the Pecos that the once populous village of 2,500 inhabitants was abandoned by its seventeen survivors in 1838, the remnant going the Jemez, where they now reside.[4] While on the way to Pecos from Tiguex (Bernalillo), in 1541, Coronado passed many villages that had recently been abandoned, and one or two others in which only a remnant was left, as we have seen. The Indians told him that a raid of the more savage tribes had decimated the inhabitants or caused them to flee to places of safety. The village of Honogee and other sites at Moenkopi were abandoned by the Hopi or Oraibi in historic times on account of the raids of the Navajos and Utes. Awatobi, on the Hopi mesas, was destroyed in 1700 by her jealous neighbors. The fourteen pueblos of the Piros along the Rio Grande in 1630 were reduced to four a half century later. "This was

4. Hodge; loc. cit., vol. 2, p. 221.

due not only to the efforts of the missionaries to gather their flock into larger pueblos, . . . but also to the danger to which the Indians were exposed from the Apaches of the 'Perrillo' and the 'Gila,' as the southern bands of that restless tribe were called."[5] Coronado found the country of the Taño (between Santa Fe and the Galisteo basin) almost depopulated on account of depredations of the Teya, a warlike tribe of the plains, sixteen years previously. He found Galisteo to be a small, strong village; the Pueblo de los Silos large, but almost abandoned; and another, farther eastward, abandoned and in ruins. Also between that time and Espejo's visit in 1583 they (the Taño) were compelled to abandon three more of their villages on account of raids of these same plains savages.[6] A short time after the destruction of the mission at Walpi in the revolt of 1680, impelled by fear of vengeance on the part of the Spaniards, as well as by the increasing attacks of the Apache, Navajo, and Ute, the village was removed to the top of the rocky mesa where it now stands.[7] "Chukubi was occupied by the Squash, Sand and other clans of the Hopi, who were afterwards joined by the Spider clan. Being harassed by enemies, among them the Ute and the Apache, it was abandoned, its inhabitants, joining those of old Mashongnovi in building the present Mashongnovi pueblo."[8] Also the whole group of Salina pueblos of the Piros east of the Rio Grande are known as the "Cities that died of fear," far in historic times, owing to Apache depredations.[9] And so on. For the same reasons and in the same manner were the villages and cliff dwellings of northeastern Arizona abandoned.

A List of the Cicadellidæ of Kansas.

P. B. Lawson.

In the fall of 1919 the writer completed a paper on the leafhoppers of the state of Kansas. As stated in the introduction to that paper, only those species were included in the fauna of the state that were represented in the Snow collections or concerning the finding of which the writer had no doubt. At that time the Crevecœur collection had not been studied, nor was the list of species in the collection of the Kansas State Agricultural College fully incorporated. In addition it was thought that records of other collectors would add to the number in the list.

Since that paper went to press the writer has had the privilege of examining the Crevecœur collection, has obtained a full list of species in the collection of the Agricultural College, and has obtained the records of additional species taken in the state by Prof. Herbert Osborn. Species included from these sources are so indicated by the parentheses following the names. The following list, therefore, I think, will be an accurate record of all the leafhoppers hitherto taken in Kansas, for it includes species hitherto unrecorded, and eliminates others which though previously recorded were seemingly wrongly determined and hence should not have been placed on the Kansas list.

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5. Handbook of American Indians, vol. 2, p. 261.
6. Idem., p. 686.
7. Idem., p. 901.
8. Idem., vol. 1, p. 295.
9. Idem., vol. 1, p. 6, under the topic "Abo."

Subfamily Bythoscopinæ (Dohrn).

Agalliopsis novella (Say).
Agallia 4-punctata (Prov.).
Agallia constricta Van D.
Aceratagallia sanguinolenta (Prov.).
Aceratagallia uhleri (Van D.).
Aceratagallia cinerea (O. & B.).
Idiocerus snowi G. & B.
Idiocerus moniliferæ O. & B.
Idiocerus ramentosus (Uhl.) [K. S. A. C]
Idiocerus alternatus Fh.
Idiocerus verticis (Say).
Idiocerus suturalis Fh.
Idiocerus pallidulus Fh.
Idiocerus duzeei Prov.
Idiocerus nervatus Van D.
Idiocerus provancheri Van D [K S A. C]
Idiocerus fitchi Van D [K. S. A. C]
Bythoscopus apicalis (O & B)
Macropsis trimaculata (Fh.).
Macropsis suturalis (O. & B).
Macropsis erythrocephala (G & B.).
Macropsis viridis (Fh).
Macropsis gleditschiæ (O. & B.).
Macropsis tristis (Van D.). [Crev]
Oncopsis distinctus (Van D.).

Subfamily Cicadellinæ Van D.

Oncometopia undata (Fabr).
Oncometopia lateralis (Fabr.).
Oncometopia lateralis var. *limbata* (Say).
Aulacizes irrorata (Fabr.).
Cicadella hieroglyphica (Say).
Cicadella hieroglyphica var. *dolobrata* (Ball).
Cicadella hieroglyphica var. *uhleri* (Ball).
Cicadella gothica (Sign.).
Kolla bifida (Say).
Kolla geometrica (Sign.).
Kolla hartii (Ball).
Helochara communis Fh.
Graphocephala coccinea (Forst.).
Graphocephala versuta (Say).
Drœculacephala mollipes (Say).
Drœculacephala angulifera (Walk.).
Drœculacephala minor (Walk.). [K. S. A. C.]

Subfamily Gyponinæ (Stal.).

Penthimia americana Fh.
Gypona 8-lineata (Say).
Gypona melanota Spangb.

Gypona pectoralis Spangb.
Gypona puncticollis Spangb.
Gypona cinerea Uhl.
Xerophlœa viridis (Fabr.).
Xerophlœa major Bak. [K. S. A. C.]

Subfamily JASSINÆ (A. & S.).

Stroggylocephalus agrestis (Fall.) [Osb.]
Memnonia consobrina Ball. [Osb.]
Memnonia fraterna Ball.
Xestocephalus pulicarius Van D.
Xestocephalus superbus (Prov).
Nionia palmeri (Van D.).
Dorycephalus platyrhynchus Osb.
Dorycephalus vanduzei O & B.
Hecalus lineatus (Uhl).
Spangbergiella vulnerata (Uhl).
Spangbergiella mexicana Bak.
Parabolocratus viridis (Uhl.).
Parabolocratus flavidus Sign.
Dicyphonia ornata (Bak.).
Scaphoideus auronitens Prov.
Scaphoideus scalaris Van D
Scaphoideus productus Osb
Scaphoideus consors Uhl. [Tuck.]
Scaphoideus intricatus Uhl.
Scaphoideus immistus (Say).
Scaphoideus melanotus Osb.
Scaphoideus cinerosus Osb
Platymetopius dorsalis Ball.
Platymetopius acutus (Say).
Platymetopius cinereus O. & B.
Platymetopius frontalis Van D.
Platymetopius scriptus Ball.
Platymetopius fuscifrons Van D. [Crev.]
Deltocephalus albidus O. & B.
Deltocephalus abbreviatus O & B. [Osb]
Deltocephalus areolatus Ball.
Deltocephalus imputans O. & B.
Deltocephalus visendus Crmb.
Deltocephalus inflatus O. & B.
Deltocephalus reflexus O. & B.
Deltocephalus sayi (Fh.).
Deltocephalus signatifrons Van D.
Deltocephalus minimus O & B.
Deltocephalus parvulus Gill.
Deltocephalus debilis Uhl.
Deltocephalus collinus Boh.
Deltocephalus affinis G. & B.
Deltocephalus oculatus O. & B.

Deltocephalus sylvestris O. & B.
Deltocephalus flavicosta Stal.
Deltocephalus weedi Van D.
Deltocephalus obtectus O. & B.
Deltocephalus inimicus (Say).
Deltocephalus osborni Van D.
Deltocephalus balli Van D.
Deltocephalus sonorus Ball.
Deltocephalus pectinatus O. & B.? [Osb.]
Deltocephalus ocellaris (Fall.)
Deltocephalus fuscinervosus Van D. [K. S. A. C.]
Deltocephalus vanduzei G. & B. [K. S. A. C.]
Deltocephalus compactus O. & B. [Crev.]
Lonatura nebulosa Ball.
Aconura robusta (Bak.).
Aconura argenteolus (Uhl.).
Driotura gammaroidea (Van D.).
Driotura gammaroidea var. *fulva* Ball.
Driotura robusta O. & B.
Euscelis magnus (O. & B.).
Euscelis exitiosus (Uhl).
Euscelis striolus (Fall.).
Euscelis parallelus (Van D.).
Euscelis extrusus (Van D.).
Euscelis uhleri (Ball).
Euscelis anthracinus (Van D.)
Euscelis striatulus (Fall.).
Euscelis comma (Van D.).
Euscelis curtisii (Fh.).
Euscelis bicolor (Van D.).
Euscelis obtutus (Van D.).
Eutettix pictus Van D.
Eutettix tenellus (Bak.).
Eutettix seminudus (Say).
Eutettix strobi (Fh.).
Eutettix cinctus O. & B.
Eutettix albidus (Ball).
Mesamia nigridorsum Ball.
Mesamia straminea (Osb.).
Mesamia coloradensis (G. & B.).
Phlepsius majestus O. & B.
Phlepsius spatulatus Van D.
Phlepsius areolatus Bak.
Phlepsius superbus Van D.
Phlepsius excultus (Uhl.).
Phlepsius decorus O. & B.
Phlepsius ovatus Van D.
Phlepsius franconianus Ball. [Osb.]
Phlepsius lascivius Ball.

Phlepsius altus O. & B.
Phlepsius incisus Van D.
Phlepsius turpiculus Ball.
Phlepsius irroratus (Say).
Phlepsius truncatus Van D.
Phlepsius lobatus Osb.
Phlepsius collitus Ball.
Phlepsius cinereus Van D.
Phlepsius punctiscriptus Van D.
Phlepsius apertus Van D.
Phlepsius fulvidorsum (Fh.).
Phlepsius nebulosus Van D.
Phlepsius solidaginis (Walk.).
Acinopterus acuminatus Van D.
Acinopterus acuminatus var. *viridis* Ball.
Thamnotettix kennicotti (Uhl.).
Thamnotettix brittoni Osb.
Thamnotettix clitellarius (Say).
Thamnotettix longulus G. & B.
Thamnotettix melanogaster (Prov.).
Thamnotettix ciliatus Osb.
Thamnotettix fitchii Van D.
Thamnotettix pallidulus Osb.
Thamnotettix nigrifrons (Forbes).
Thamnotettix inornatus Van D. [Tuck.].
Chlorotettix necopinus Van D.
Chlorotettix spatulatus O. & B.
Chlorotettix unicolor (Fh.).
Chlorotettix viridius Van D.
Chlorotettix balli Osb.
Chlorotettix lusorius (O. & B.). [Tuck.].
Chlorotettix tergatus (Fh.).
Chlorotettix vividus Crmb.
Chlorotettix galbanatus Van D.
Chlorotettix tunicatus Ball.
Jassus olitorius Say.
Neocœlidia tumidifrons G. & B.
Cicadula punctifrons (Fall.).
Cicadula punctifrons var. *repleta* Fieb.
Cicadula variata (Fall.).
Cicadula lepida Van D.
Cicadula sexnotata (Fall.).
Balclutha punctata (Thunb.).
Balclutha impicta (Van D.).
Eugnathodus abdominalis (Van D.).
Alebra albostriella (Fall.).
Alebra albostriella var. *fulveola* (H. S.).
Dikraneura abnormis (Walsh).
Dikraneura flavipennis (Zett.). [Tuck.]

Dikraneura fieberi (Loew.).
Empoasca trifasciata Gill.
Empoasca obtusa Walsh.
Empoasca albolinea Gill.
Empoasca alboneura Gill.
Empoasca mali (LeB.).
Empoasca flavescens (Fabr.).
Empoasca aureoviridis (Uhl.). [K. S. A. C.]
Empoasca viridescens Walsh. [Tuck.]
Typhlocyba rosæ (Linn.).
Typhlocyba querci var. *gillettei* Van D.
Hymetta trifasciata (Say).
Erythroneura tricincta Fh.
Erythroneura basilaris (Say).
Erythroneura rubroscuta (Gill.).
Erythroneura illinoiensis (Gill.).
Erythroneura maculata (Gill.).
Erythroneura scutelleris (Gill.).
Erythroneura crevecœuri (Gill.).
Erythroneura comes (Say).
Erythroneura comes var. *vitifex* Fh. [K. S. A. C.]
Erythroneura comes var. *ziczac* Walsh.
Erythroneura comes var. *vitis* (Harr.).
Erythroneura comes var. *infuscata* (Gill.).
Erythroneura comes var. *coloradensis* (Gill.).
Erythroneura comes var. *octolineata* Walsh. [Tuck.]
Erythroneura obliqua (Say).
Erythroneura obliqua var. *nœvus* (Gill.).
Erythroneura dorsalis (Gill.).
Erythroneura fumida (Gill.).
Erythroneura vulnerata Fh.
Erythroneura nigra (Gill.).

A List of the Grasses of Douglas County.

P B Lawson.

While studying the leafhoppers of the state of Kansas the writer became interested in the grasses upon which these insects were found and in the seemingly large number of species that occurred within the boundaries of a single county.

This led to a study of the local flora in the field and to a simple study of the literature dealing with the records of the plants found in the county. The latter study revealed the fact that in late years very little work has been done in Kansas along this line, though in earlier years Prof. James Carruth, of the State University, and Professors Kellerman and Hitchcock, of the State Agricultural College, published several lists of the grasses found in the different parts of the state.

Most of the species recorded below have been seen by the writer. Some, however, are included in the list on the authority of the above men; a few added on the authority of Mr. Smyth; several species are represented in the herbariums of the State University and the State Agricultural College, which the writer has not seen in the field; and a few species are included on the authority of Dr Grace Charles, of the botany department of the University of Kansas, to whom the writer is indebted for most generous help and instruction in the working out of this list. Species included in the list on the authority of any of the above, bear their names in parentheses.

Tribe MAYDEÆ.

Tripsacum dactyloides L.

Tribe ANDROPOGONEÆ.

Schizachyrium scoparium (Michx.) Nash.
Andropogon furcatus Muhl.
Sorghastrum nutans (L.) Nash.
Holcus halepensis L

Tribe PANICEÆ.

Syntherisma sanguinale (L) Dulac.
Leptoloma cognatum (Schultes) Chase.
Eriochloa punctata (L.) W Hamilton.
Paspalum stramineum Nash.
Paspalum setaceum Michx.
Echinochloa crus-galli (L.) Beauv.
Panicum dichotomiflorum Michx.
Panicum capillare L.
Panicum virgatum L.
Panicum anceps Michx. [Carruth.]
Panicum agrostoides Spreng. [K. S. A. C.]
Panicum sphærocarpon Ell.
Panicum dichotomum L.
Panicum huachucæ Ashe.
Panicum leibergii (Vasey) Scribn.
Panicum scribnerianum Nash.
Panicum oligosanthes Schalt. [Carruth.]
Panicum Wilcoxianum Vasey.
Panicum scoparium Lam.
Panicum clandestinum L.
Chætochloa glauca (L.) Scribn.
Chætochloa viridis (L.) Scribn.
Chætochloa italica (L.) Scribn.
Cenchrus carolinianus Walt.

Tribe ORYZEÆ.

Homalocenchrus virginicus (Willd.) Britton.
Homalocenchrus oryzoides (L.) Poll.

Tribe PHALARIDEÆ.

Phalaris arundinacea L. [Carruth.]

Tribe Agrostideæ.

Stipa spartea Trin.
Aristida oligantha Michx.
Muhlenbergia schreberi Gmel.
Muhlenbergia sobolifera (Muhl.) Trin.
Muhlenbergia mexicana (L.) Trin.
Muhlenbergia racemosa (Michx.) B. S. P.
Muhlenbergia tenuiflora (Willd.) B S. P.
Muhlenbergia cuspidata (Torr.) Nash. [Carruth.]
Brachyelytrum erectum (Schreb) Beauv. [Smyth.]
Phleum pratense L.
Alopecurus geniculatus L. [K. S. A C.]
Sporobolus vaginæflorus Torr
Sporobolus neglectus Nash
Sporobolus asper (Michx) Kunth.
Sporobolus angustus Buckley [Carruth.]
Sporobolus cryptandrus (Torr.) A. Gray.
Sporobolus heterolepis A. Gray. [Carruth.]
Agrostis alba L
Agrostis canina L.
Agrostis altissima (Walt.) O. Tuckerm. [Carruth.]
Agrostis hyemalis (Walt.) B. S. P.
Calamagrostis canadensis (Michx) Beauv. [Carruth.]

Tribe Chlorideæ.

Capriola Dactylon (L) Kuntze
Spartina Michauxiana Hitchc
Chloris verticillata Nutt.
Schedonnardus paniculatus (Nutt.) Trelease.
Bouteloua hirsuta Lag. [Carruth.]
Bouteloua oligostachya (Nutt.) Torr.
Ætheropogon curtipendulus (Michx) Tourn.
Eleusine indica (L.) Gaertn.
Leptochloa filiformis (Lam.) Beauv. [Carruth.]

Tribe Festuceæ.

Phragmites phragmites (L.) Karst.
Tridens flava (L.) Hitchc.
Triplasis purpurea (Walt.) Chapm. [Carruth.]
Diplachne fascicularis (Lam.) Beauv. [Carruth.]
Eragrostis capillaris (L.) Nees. [Carruth.]
Eragrostis hirsuta (Michx.) Nees.
Eragrostis Frankii Steud. [Carruth.]
Eragrostis pilosa (L.) Beauv.
Eragrostis major Host.
Eragrostis pectinacea (Michx.) Steud.
Eragrostis trichodes (Nutt.) Nash. [Carruth.]
Eragrostis hypnoides (Lam.) B. S. P.
Sphenopholis obtusata (Michx.) Scribn.
Sphenopholis pallens (Spreng.) Scribn.

Kœleria cristata (L.) Pers.
Melica mutica Walt.
Korycarpus arundinaceus Zea. [Carruth.]
Uniola latifolia Michx.
Dactylis glomerata L.
Poa pratensis L
Poa autumnalis Muhl. [Smyth.]
Poa sylvestris A Gray.
Poa compressa L.
Panicularia nervata (Willd) Kuntze.
Panicularia grandis (S. Wats) Nash. [Smyth.]
Festuca octoflora Walt. [Carruth.]
Festuca ovina L. [Carruth.]
Festuca elatior L.
Festuca nutans Willd.
Bromus ciliatus L.
Bromus inermis Leyn
Bromus hordeaceus L
Bromus secalinus L
Bromus racemosus L.

Tribe HORDEÆ.

Lolium perenne L
Agropyron tenerum Vasey
Hordeum nodosum L.
Hordeum pusillum Nutt.
Hordeum jubatum L
Elymus virginicus L
Elymus canadensis L.
Elymus brachystachys Scribn & Ball [Charles]
Elymus striatus Willd
Hystrix hystrix (L.) Millsp. [Carruth]

Field Work in Kansas and Texas.

By CHARLES H STERNBERG

On April 7, 1919, we left Lawrence in my Ford truck for western Kansas. Mr. Knoblock, of Quincy, Ill, was my driver. After a very disagreeable journey of seven days, on account of rain and bad roads, we reached Quinter, Kan. The next day we made our camp in Mr. Sampson's pasture on Hackberry creek. The canyons were filled with great snowdrifts, and the weather was bad for some time.

Two miles east of camp I found a beautiful plate of the crinoid *Uintacrinus socialis*. They covered an area of eighteen square feet. In one case the arcs were spread over the plate for over three feet. This I sent to the state museum at Albany, N. Y.

After leaving this camp we went to the head of the canyon, east of Monument Rocks, in western Gove county. Mr. Lester Olds was my assistant, as Mr. Knoblock had returned home. Here I discovered two very fine specimens.

The first was a nearly complete skeleton, in its natural position, of the small *Pteranodon*. This is the only *Pteranodon* I ever discovered with the bones of the skeleton in place. The American Museum had been unable to mount their skeletons, as the normal position of the vertebræ was unknown. They purchased this specimen and their skilled preparator, Falkenback, prepared it.

The second specimen was a nearly complete skeleton of *Clidastes tortor*. The skull is uncrushed and shows the pterygoid bones, armed with teeth in front of the gullet. It is twelve feet long and I have mounted it in panel. I also secured one of the large *Inoceramus* shells, over three feet in length. This I sent to the British Museum.

My third camp was made at Mr. Martin's ranch, south of Castle Rock, on the brakes of the Smoky Hill river north of Utica. Here I was left entirely alone and had a severe time of it. I was so fortunate, however (and that really is what counts), as to find a splendid skeleton of *Platecarpus*, with all the paddles, breastbones and cartilaginous ribs Only a few terminal caudal bones were missing from the skeleton I found it very difficult to handle the big sections in which I took it up. There were two, and they weighed about 500 pounds each. However, by using all the skill I had I succeeded in accomplishing the labor of turning them over. I have mounted this skeleton in a panel. It is 18½ feet long.

The second remarkable fossil vertebrate found here was the skeleton of a *Portheus*. It was preserved from the pelvic fins to the end of the tail, and is the largest *Portheus* I have seen. The spread of the tail fins is five feet. In 1918 my son Levi found a skull and body part of a *Portheus* that is so near in size to this one that I have made a composite skeleton of the two. It is sixteen feet long and will be, as I said, the largest bony fish ever collected from the Cretaceous.

I also found the tail fins, that are the same size as the ones missing from the splendid skeleton we got on Butte Creek in 1918. This I have used in my panel mount of this beautiful fish. It is thirteen feet long, and shows for the first time the spines and supernumeraries. So the correct anatomy of this great fish can now be correctly made out. The one I sent the American Museum years ago had no spines and they were restored as straight, pointed shafts with supernumeraries terminating in clublike ends. A number of others have been mounted that copied this error. In this specimen the spines form a double curve and the supernumeraries the arc of a circle. They lie along the upper curves of the dossal spines.

Mr. Ikenberry drove me down to Gidley's "horse quarry," on the head of Rock creek, in Bristow county, Texas. We went into camp on the 27th of August. Ten skeletons of *Equus scotti* had already been taken out of this quarry. I succeeded in securing the eleventh skeleton. According to Doctor Troxell, the last collector here, the bodies had been carried in by water. He found all the heads pointed toward the east. This helped him form his judgment as to deposition. The head of my skeleton, however, was pointed toward the west. It is also incredible to believe that the bodies, after death by drowning, would rise to the surface and float all together at the same time and be left stranded together at this place. I much prefer to believe that, following the custom of wild horses, their leader, a stallion, had driven them here for water and they got stuck in the quicksand, as the sand in which

they are buried becomes quicksand when full of water, and animals to-day are lost where a stream of water flows over it.

All the specimens had been preyed upon by carnivores, it is evident, as parts of the skeletons have been disassociated. In my specimen the right leg, tail and some of the ribs were missing. Some of the ribs had been broken off in their centers, the distal ends missing. A high perpendicular bank on the south side of the quarry had been caved off into it, so I realized the only thing to do was to open a new one. This was a formidable undertaking. I secured the services of a farmer near by, Mr. Stephenson, who with his three sons and three teams and plows and scrapers went to work at $25 a day. We removed a section of clay and sand 20 feet wide, 20 feet deep and 100 feet long to get down to the level, which lay about three feet below a thin layer of clay. We got below the floor in many places and I had about given up hope of making a discovery. One day at noon I had gone in to boil some coffee, as we lunched together. Mr. Stephenson came to lunch and he had a bone of a horse he had plowed up. What a pleasure and surprise. It will cost a good deal of money to lay bare another section to the south, the hill behind it rising rapidly. I have since prepared the specimen into an open mount. I found it difficult work preparing the material, as the bones were fragile and required a great deal of care The bones had to be strengthened with shellac, and the ribs were strengthened by putting strips of steel in their centers. The skull was over two feet long. With the skeleton is most of the breastbone.

Doctor Francis, of the State College of Texas, came to see it. He pronounces it a four-year-old mare.

I was also so fortunate as to find the hind limbs, pelvic arch and twenty vertebræ of a great bear, which Doctor Matthew tells me is very rare indeed. He was delighted to receive it at the American Museum, New York. On the 27th of September, a month after I reached my camp on Rock creek, I employed Tom McDaniels to drive me home to Lawrence, Kan. We made the trip in five days. The last day we traveled 200 miles. I have been at work ever since preparing the material collected.

Education: Physical and Mental.

J. M. McWharf.

Nature and humanity are the sources from which has come the inspiration essential to the highest development and usefulness of mankind. Comenius deduced his principles of education from nature. Locke preferred the influence of virtuous, humane man. Rousseau, seeing man perverted through his training, believed nature the only true guide. Pestalozzi again is enthusiastic for humanity. And so on down the ages to Wordsworth and Browning, until we are forced to believe that it must be in the nice balance of those necessities natural and human that we shall find the law of perfect growth.

By careful inspection we find there are three essentials necessary in the child's education. First, a development of the mental—a broadening and deepening of the intellectual powers, the power of thought and reason. This work cannot be done with any degree of safety unless coupled with a corresponding physical development. There must exist a perfect coördination be-

tween the physical and mental. Dwarf the physical and advance the mental and you produce, as a rule, an intellectual monstrosity. If you develop a physical Hercules and neglect the mental you have failed in the great purpose of life. If both physical and mental are fully developed and in perfect harmony, there should be engrafted upon each soul a part of the Master's life. We will then have the strong head and the strong hand working together under divine directions. A complete character must have physical elements as well as intellectual and religious elements. The character can be complete only when each of its elements have been made as perfect as possible. The omission of an element or its reduction below a possible standard of power weakens character. A character builder must make each part of the structure as strong as conditions warrant. Physical culture is an important factor in character building, as it has a beneficial influence on the elements from which character is constructed. The central element in a well-developed character is a strong, active, well-poised mind. A strong character is one with sufficient executive power to have its decisions carried out The power to decide correctly is essential, but executive energy is necessary to transform wise decisions into moral forces.

The basal elements in character are an active, well-balanced mind and a strong, well-nourished, responsive body. Physical training helps to secure both. Wise physical culture will strengthen all of the vital organs of the body and increase their functional power Many people could be improved in character quality and character force if it were possible to exchange their stomachs, lungs, livers and hearts for new and perfect organs. This cannot be, but by proper treatment their organs may be improved.

The brain responds more quickly and fully than the other organs to the circulation of pure, rich, red blood which is obtained by good digestion and full breathing of pure air. Physical training does more than develop the cells of the brain. It aids in the extention and coordination of the entire neurological system. The body in time becomes an external manifestation of the individual's character. The body and the mind are so intimately interrelated that the one of a necessity reacts on the other. If you change a boy's step from a shuffling gate to a definite, free step, you have helped to change his character. Watch that jerky boy and you learn that his temper and character have like conditions; that they correspond to every jerk and angle. Give him proper physical training and his character will tend to conform to the altered conditions. His action gains in force what it loses in spasmodic energy. He doubtless will live longer, for you have substituted calmness for petulence and rhythm for spasmodic efforts. The body reveals the character and helps to form it. Rousseau said. "The weaker the body the more it commands; the stronger it is the more it obeys." A wise instructor knows that timely practice of physical exercise is the surest and the quickest way to secure order, system and cooperation in a disorderly, irregular and indifferent class. There is nothing better for moral influence than games. The child enjoys them and they accomplish a definite purpose, as self-control and self-direction. There is no school work that defines energy of character more than games. By the playing of games the boys and girls learn to bear defeat and to work harder for a victory to-morrow. We have no better place for developing the consciousness of individual power than that of cricket, football

or baseball, and the more completely this power is developed the more perfectly will the boy or girl be able to perform their part and the more certain they are of victory. Combined, thorough training usually means victory. Plato said: "If children are trained to submit to laws in their plays the love for law enters their souls with the music accompanying the games. It never leaves them, but helps in their development." Everlasting vigilance, coupled with wisdom must be exercised. Give the boy and girl literature that is good; aim to establish in them a desire for the best course of reading and study In all things conserve their mental and physical Let us be sane in whatever work we demand of them. The boy and the girl should leave the parental roof with habitual actions so fitted to their natures, so appropriate to their special needs and so firmly implanted within their being that they may be trusted to bear them safely along the right course later in life. Perchance there may be a breaking up of old ideas and habits in after life. We may be adrift at sea, and it is in such crucial places that this life book (of which we have been making) may prove a trusted friend and counselor

Fossils from the Western Front.

FRANK P STRICKLAND, JR

When the American First Army took over a sector of the western front in 1918 the troops entered trenches that had been held by the French almost from the beginning of the war. These trenches were located in a so-called "quiet sector," north and northwest of the fortress of Toul, and because of a minimum of artillery bombardment were in a fair state of preservation. The trenches were for the most part dug in soil containing soft limestone with some shale, the stone being sufficiently rotten as to allow of its being worked with pick and shovel. The soil from the trenches, thrown out on either side, had by 1918 become so disintegrated that the finer particles had settled or disappeared, leaving the more resistant particles on the surface. Among these were many fossils of the Carboniferous, for the rocks of this sector are Carboniferous and form the northeast rim of the great Paris basin.

In the bustle and excitement incident to taking position on the line there was little opportunity to study fossils, but as things settled a bit the thoughts of home brought memories of the collection of fossils gathered from the hillsides of Wyandotte, and a desire was formed to add to that collection some of the specimens from the land of our French comrades. And so a number of fine brachiopods, ammonites, lamellibranchs, echinoderms and crinoid stems were gathered from the edges of the trenches and from shell holes at such times as it was possible to get one's head above the top without arousing enemy snipers. The brachiopods resembled our *Terebratula, Atrypa, Pugnax, Spirifer,* etc.; forms of ammonites also resembled ours, and there were specimens resembling *Archæocidoris, Schizodus* and *Laphophyllum.*

As soon as the Yanks became settled in their new position it ceased to be a "quiet sector." The change can be best illustrated by an incident that occurred about this time. For three years the hostile armies had watched each other with an occasional exchange of shots but with no real fighting. Midway between the lines was the wreck of a small village which contained a well and

small creek. The French had been in the habit of using this well and stream on certain days of the week, while the Germans used them the remainder of the week. The first day that the Germans went to the well after the Americans took charge the Yank artillery opened up and blew up the well, creek and all Germans in sight and then smashed the German trenches. This naturally caused the Germans to do some firing in return, with the result that some of the American trenches were damaged. The shell holes caused in this duel uncovered some fine echinoferms, which were added to the collection. In the raiding and fighting at night in no man's land it was often necessary to hide in shell craters while star shells filled the air, and many of these echinoderms could be picked up if one could keep his mind away from the poison gas and shrapnel long enough to think of such matters. These echinoderms were very common in that sector and were of two sizes, one about an inch in diameter and the other about three inches, and were well preserved. These were the only forms of fossils found in shell holes in this sector, which was on the edge of the farm village of Mamey. The other fossils found here were taken from the soil removed from the trenches. Evidently they could not resist the exploding shrapnel as could the large, heavy echiroderms, and were probably pulverized by the explosion.

In digging trenches preparatory to the "jump-off" at the beginning of the Argonne, the collection was further enlarged by the addition of more brachiopods and a number of lamellibranchs from the neighborhood of Thiaucourt and further north. As the second American army prepared for its drive against Metz in October and November, 1918, more eichnoderms were picked up in shell craters southwest of the city.

When the troops began moving back off the line after the armistice, preparatory to establishing winter camps, a camp was established in an old German camp on the heights of Woinville, near St. Mihiel on the western edge of the great Waevre plain. At the base of one of the hills was a shell crater made by Allied artillery in the St. Mihiel drive of September 12 and 13, 1918. It was about twenty feet in diameter and perhaps fifteen feet deep. The soil in the hole had been pulverized by the explosion, and the three months of almost constant rain that followed had caused the finer particles to settle, leaving many brachiopods and ammonites, as well as a few crinoids, exposed. Curiously no echinoderms were found, this condition being the reverse of that farther east in newly made shell holes, although they may have been present in other shell holes near by which did not come under observation.

New Years Day, 1919, a party of officers stationed near Toul visited the old German lines near Apremont and Varnieville on the old St. Mihiel salient, near the city of St. Mihiel. Jutting out from the heights near these villages into the Waèvre plain is a high promontory-like hill, which was used by the Germans as a stronghold. It was crowned by a complicated system of trenches, dugouts and "pill boxes," and its interior contained many passages and vaults. The rock in the hill was similar to oölitic limestone found in this country, and the soil thrown out of the excavations contained fossils in abundance, and it required only a few minutes to pick up a large assortment of brachiopods and crinoids, including a form having a stem with a pentagonal cross section;

forms resembling our *Archæocidaris, Schizodus* and *Laphophyllum* were picked up, but no echinoderms were found.

All these fossils eventually reached America, and now form part of a collection in Kansas City, Kan. Due to the constant change of station, it was impossible to get in touch with any literature or any person who could help in identifying the specimens. However, correspondence is now going forward with scientists in France with this end in view.

An Annotated List of Some Kansas Pleurosticti (Scarabæidæ).*

J W McCOLLOCH and W P HAYES

As a part of the study on insects injurious to the roots of crops being conducted at the Kansas Agricultural Experiment Station, the writers have devoted considerable time to collecting and making observations on the various species of Scarabæidæ belonging to the subfamilies Melolonthinæ and Pleurosticti Many of these are injurious, in the larval or adult stages, to crops of various kinds. In many cases little is known regarding the distribution, life history, habits and food of the different species. During the past winter the writers have studied all of the specimens of the subfamily Pleurosticti in the collection of the Kansas State Agricultural College and have assembled the notes made by them during the past few years. Most of the literature dealing with Kansas Coleoptera has also been gone over. The present paper is the result of this work and is given at this time in the hope of adding to the meager knowledge of this group and in stimulating others to further observations. The arrangement of Casey (1915) has been followed in listing the species.

Rhombonalia comes Casey

Trego, Russell and Wallace counties. June, July. Casey (1915, p. 6) also reports it from Rooks county.

Anomala binotata Gyll.

Throughout the state; common. April, May. The biology of this species in Kansas has been reported by one of the writers (Hayes, 1918).

Anomala ludoviciana Schf.

Riley and Gove counties; not common. April, May. Six specimens were in the collection studied. One was taken on a plum tree on May 9.

Anomala stigmatella Casey.

McPherson county (Casey, 1915, p. 22).

Anomala near *flavipennis* Burm.

Riley county; not common. June 18 to July 21. Seven specimens have been collected at lights. Adults have also been reared from grubs collected under logs and around corn roots. Pupation occurs June 4 and the pupal stage lasts about fifteen days. Snow (1883, p. 58) reports this species from Douglas county.

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* Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 56. This paper embodies the results of some of the investigations undertaken by the authors in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station.

Anomala flavipennis modulata Casey.

Ellis county. July 13. One specimen taken along Big creek. Casey (1915, p. 23) reports this subspecies abundant in McPherson and Russell counties.

Anomala undulata Mels.

Shawnee and Riley counties; common. June, July. Popenoe (1877, p. 30) lists this species, under the name of *Anomala varians* Fabr., as common in eastern Kansas. The writers have taken this species in flight at 2 p.m. and have reared it from grubs collected in wheat and corn fields. Pupation occurs about June 1 and the pupal stage averages fifteen days Popenoe (1881, p. 481) reports the beetles abundant in cornfields on the corn leaves associated with *Anomala innubia* Fabr.

Anomala nigropicta saginatula Casey.

Riley county; frequent May 12 to June 13. This species has been taken at lights and in the curl of corn plants

Anomala innubia Fabr.

Riley and Shawnee counties; common. June, July. Knaus (1893, p. 294) has found this species in the sand hills near Medora. The writers have reared adults frequently from grubs collected around the roots of corn. Pupation begins early in June and the length of the pupal stage is about thirteen days. Popenoe (1881, p. 481) says that this species is common on corn leaves in company with *Anomala undulata*. This species has been confounded with *Anomala minuta* Burm in previous Kansas lists.

Anomala medorensis Casey.

Pottawatomie, Reno and Wilson counties (Casey, 1915, p. 35).

Spilota marginata Fabr.

Nemaha, Shawnee and Riley counties; rare. June, July

Spilota lucicola Fabr

Kansas (Casey, 1915, p. 46).

Strigoderma obesula Casey.

Kansas (Casey, 1915, p. 54).

Strigoderma obesula quarternaria Casey.

Kansas (Casey, 1915, p. 55).

Strigoderma arboricola Fabr.

Throughout the state, being more abundant westward; common. June, July. Fifty-three specimens were collected in a single day of general collecting at Wallace. Adults were abundant on rose blossoms at Abilene in June, 1919. Life-history studies of this species are now under way The egg stage was found to average 11.4 days in 1919. Grubs are now being successfully reared in soil with bran and wheat for food.

Strigoderma viridicollis Schf.

Wallace and Kingman counties; rare. July.

Strigodermella pygmæa Fabr.

Riley and Kingman counties; rare. June 26 to July 13. The Riley county specimens were taken on the sand hills four miles south of Manhattan.

Pelidnota punctata Linn.

Throughout the state as far west as Dodge City; common. May 20 to August 1. The adults are very common at lights and have also been taken feeding on wild and cultivated grapes and on spinach. One adult was found in the stomach of a toad. The grubs feed on decaying wood, principally

apple and elm. Over 300 grubs were found in a single apple tree at Anthony in 1918. The life history of this species is now being worked out. Oviposition may begin as early as June 19, the eggs being deposited under logs and probably in decaying wood. The length of the egg stage averages fifteen days. The pupal stage occupies about twenty days.

Cotalpa subcribrata Wick.

Western and southwestern Kansas; frequent. May, June. Knaus (1908, p 91) reports this species fairly common at Medora in 1907 during the last two weeks of May and the first half of June. They were found during the day clinging to the twigs and foliage of the scrub willows growing on the sand hills.

Cotalpa lanigera Linn.

Eastern Kansas; not common. May 26 to August 7. The adults have usually been collected at lights Willow is the only food plant recorded for this species in Kansas In cages they also fed readily on elm, poplar and cottonwood and very sparingly on maple Knaus (1901, p. 114) reports it common on willow catkins at Medora.

Polymœchus brevipes Lec.

One specimen is in the collection of the State Agricultural College labeled "Kansas." Popenoe (1877, p. 30) records it from Lawrence, and Knaus (1901, p. 112) reports taking two specimens in electric-light globes at McPherson late in July.

Ochrosidia rufifrons Casey.

Kansas (Casey, 1915, p. 145).

Ochrosidia (Cyclocephala) immaculata Oliv.

Throughout the state, common June, August. The adults are strongly attracted to lights. Adults have also been found feeding on pigweed, lamb's quarter and gouging into peaches that have fallen on the ground The grubs are most commonly found in wheat and corn fields, although they have been taken in sod land, alfalfa fields, garden plots and orchards. The life history of this species has been reported by one of the writers (Hayes, 1918) under the name *Cyclocephala villosa* Burm.

Ochrosidia tenuicutis Casey.

Wallace county. July. Casey (1915, p. 146) describes this species from Douglas county.

Ochrosidia prona Casey.

Wallace county; rare. July.

Dyscinetus puncticauda Casey.

Ford and Hamilton counties; frequent. May 11 to August 1. Adults are common at lights. This is probably the species referred to by Popenoe (1877, p. 30) as being "more strongly punctured than *obsoletus* (Lec.), size of *Ligyrus relictus* (Say), Dodge City." Casey did not have the female at hand in describing this species. The collections studied by the writers show the proportion of sexes to be about equal. The males differ from the females in having the last ventral segment emarginate.

Dyscinetus trachypygus Burm.

Ford, Reno, Riley and Shawnee counties; frequent. April 18 to July 21. The adults are frequently found around electric lights.

Ligyrodes (Ligyrus) relictus Say.

Throughout the state; common April, August. The adults are common around electric lights and in the soil. They have also been found in drift being carried in the streams after rains. The winter is passed in the adult stage, and in the spring the beetles may be found under manure in

the fields, where mating has been observed to occur. Eggs, which are laid in June, hatch after nine or ten days. The grubs feed in manure and rotten straw and reach the pupal stage from July to October. The semi-pupal stage varies from two to twelve days, with an average of four days, and the pupal stage averages fourteen days, with extremes of nine and nineteen days. There is but one generation annually.

Euetheola (*Ligyrus*) *rugiceps* Lec.

Winfield; rare. July 31. One specimen was taken in the soil of a cornfield. This is the first record so far known of this species occurring in this state. This species is a serious pest of corn in some of the Southern states.

Ligyrus gibbosus DeG.

Throughout the state; common. March-October. The adults are commonly found around lights and at the roots of sunflowers, cockleburs, celery and sugar beets. The life history of this species has been reported by one of the writers (Hayes, 1917).

Ligyrus bicorniculatus Casey.

Kansas (Casey, 1915, p. 198). This species is described from a female collected in this state.

Pseudaphonus pyriformis Lec.

Russell, Logan and Wallace counties, evidently common in the western part of the state. June, July. One specimen collected in eastern Colorado was taken at the roots of sunflower. On more careful study some of the specimens at hand might agree with some of Casey's new Colorado species of this genus. One unique in the series at hand has an impressed median line on the thorax.

Aphonus tridentatus Say.

Western Kansas (Popenoe, 1878, p. 81).

Strategus atrolucens Casey.

Sedan; rare. June 20.

Strategus antæus Fabr.

Topeka (Popenoe 1877, p. 30); Sedan (Knaus 1905, p. 219).

Strategus mormon Burm.

Reno county (Casey, 1915, p. 251). According to Warren (1917, p. 413), *mormon* is a true sand-hill species, where it is found abundantly at Sylvia. He found that the eggs were laid in holes eighteen inches deep, which were then filled with layers of old, dry horse manure. He suspects a three-year life cycle. All specimens were collected from the middle of May throughout the month of June.

Xyloryctes satyrus Fabr.

Lyon and Riley counties; rather frequent. April-October. Popenoe (1877, p. 30) reports this species from Lawrence and Topeka.

Dynastes tityrus Linn.

Cowley county; rare. July 11. Popenoe (1877, p. 30) lists this species from the Smoky Hill river, and Snow (1883, p. 58) reports it from Chautauqua county.

Phileurus texensis Casey.

Riley county; frequent. May, June. Popenoe (1877, p. 30) says it occurs in eastern Kansas. This species is sometimes labeled *P. valgus* Burm. in collections. According to Casey (1915, p. 270) *valgus* does not occur in this country.

Cotinus nitida Linn.

Kansas; rare. Popenoe (1877, p. 30) records this species from Neodesha.

Cotinus nitida ornata Casey.

Winfield; rare. July. One specimen was taken in a cornfield.

Euphoria fulgida Fabr.

Riley, Shawnee, Gove and Ellis counties; common. May-August. The adults have been taken feeding on the blossoms of dogwood, thistle and white clover, on grass in pastures and on ripe peaches and cherries. Popenoe (1877, p. 30) also reports this species on milkweed.

Euphoria inda Linn.

Throughout the state; common. April-October. The adults have been taken feeding on sunflowers, plum trees, frosted beans, thistle blossoms and ears of corn. In Kansas this species sometimes injures ripe fruit and ears of corn. The beetles appear in April and May and eggs are deposited during May and June. The egg stage has been found to vary from seven to eleven days. The grubs develop rapidly in manure and soil rich in decaying organic matter. When ready to pupate they construct a cell of earth or dung. Pupation occurs in July and the pupal stage averages fourteen days, with extremes of twelve to sixteen days. Adults reared in July become active early in August. Damage is done at this time to corn and fruits, and the beetles are also found abundant in the blossoms of thistles. The beetles remain active until frost, when they go into hibernation, to reappear the following spring. In a soil cage maintained in a cave during the winter seventeen beetles out of fifty-eight survived. There is but one generation a year.

Euphoria rufobrunnea Casey.

Russell, Trego, Wallace and Seward counties; occasional July, August. Most of the specimens at hand have been collected on weeds.

Euphoria clarki Lec.

Western Kansas; fairly common. May-July. The adults frequent flowers, especially those of thistles, into which they burrow.

Euphoria wichitana Casey.

Russell, Ellis, Wallace, Kearny and Ford counties; frequent. June, July. Usually taken in blossoms of thistle. This species was originally described from Wallace county.

Euphoria kerni Hald.

Throughout the western third of the state; common. June, July. Adults usually taken on flowers, especially those of thistle. Popenoe (1877, p. 30) lists this species as occurring on prickly poppy.

Euphoria texana Schauf.

Throughout the western third of the state; frequent. May-July. This species usually occurs on the same plants with *kerni*, and for some time was considered as a black variety of that species.

Euphoria æstuosa Horn.

Riley county; rare. Two specimens are in the collection of the Agricultural College from Riley county, but without further data.

Euphoria sepulchralis Fabr.

Riley, Shawnee, Russell and Wallace counties; common. May-October. This species probably occurs throughout the state. The adults have a wide range of food plants, having been taken on the flowers of thistle, goldenrod, dogwood, snow on the mountains, polygonum, sunflower and spirea. They have also been found gouging the fruit of apple, peach and plum, and have been swept from milkweed, grindelia and boneset. The beetles have been taken in the soil of plowed wheat land, in swamp land and on sand hills. A grub of this species collected under dung in a pasture July 19, 1918, pupated August 27, 1918, and became adult September 9, 1918. This grub formed a small earthen cell in which to pupate.

Euphoria sepulchralis kansana Casey.

Riley county; at times abundant. September. The adults have been taken on the blossoms of goldenrod. Casey (1915, p. 321) records this subspecies from Muncie, Kan.

Euphoria sepulchralis cuprascens Casey.

Riley county; rare. September. Casey (1915, p. 322) describes this subspecies from Medora and suggests that it is probably a local race in this zoölogically somewhat isolated region.

Stephanucha pilipennis Kr.

Riley, Reno and Gove counties; frequent. May-October. This species seems to be restricted to sand-hill areas. At Manhattan they are numerous during July, flying over sandburs in fields in the sand hills along the Kansas river. They are especially abundant on clear, hot days between 9 and 12 a.m. Regular collections made during the summer of 1902 show that the maximum flight occurred about July 22. Popenoe (1877, p. 30) reports this species under the name *Euphoria areata* Fabr., as occurring on thistle heads in western Kansas. According to Knaus (1899, pp. 37, 38) *pilipennis* is one of the rarest of scarabæids He found it from May 1 to May 20 crawling sluggishly over the sand at Medora, and suggests that the latter part of April would furnish the best collecting.

Cremastocheilus canaliculatus Kirby.

Lawrence (Knaus, 1905, p. 219).

Cremastocheilus castaneæ Knoch.

Eastern Kansas (Knaus, 1905, p. 219).

Cremastocheilus incisus Casey.

Kansas (Casey, 1915, p. 351).

Cremastocheilus nitens Lec

Riley and Gove counties; common. April-August Knaus (1901, p. 115) records it from the sand-hill region about Medora. In Riley county this species has been common in pastures and sandy areas Grubs collected in July and August under logs on a sand flat along the Kansas river pupated the latter part of July and during August. The semipupal stage varied from two to five days, with an average of three days. The pupal stage ranged from nine to eighteen days, with an average of twelve days for sixteen individuals.

Cremastocheilus knochi Lec.

Riley and Logan counties; frequent. April-June Snow (1878, p 66) also records this species from Gove and Wallace counties.

Cremastocheilus knochi gracilipes Casey.

Cheyenne county (Casey, 1915, p 360).

Trinodia (*Cremastocheilus*) *saucia* Lec.

Wallace county (Snow, 1878, p. 66); Kansas (Casey, 1915, p. 367).

Trinodia setosifrons Casey.

Clark county; elevation, 1,962 feet (Casey, 1915, p. 368).

Osmoderma eremicola Knoch.

Riley and Russell counties; frequent. May-August. The adults, larvæ and pupæ have been taken in the decaying stumps of apple trees. Before pupating the larva constructs a spherical cell of bits of wood and refuse.

Trichiotinus (*Trichius*) *piger* Fabr.

Riley, Pottawatomie and Shawnee counties; common. May-July. The adults have been found feeding on wild rose and sumac. The grubs are found in decaying wood and old logs. Two reared individuals pupated in June and matured June 25 and July 1.

Trichiotinus (*Trichius*) *texana* Horn.

Riley, Pottawatomie and Dickinson counties; frequent. June. The adults have been taken on Jersey tea in bloom and on rose blossoms in company with *T. piger* and *Strigoderma arboricola*. They are also attracted to lights.

Valgus squamiger Beauv.

Eastern Kansas; comparatively rare. May. The record of Popenoe (1877, p. 30) concerning *V. canaliculatus* Fabr. probably refers to this species. He says it occurs under logs and in rotten wood. Snow (1881, p. 78) lists this species from Leavenworth county.

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A Preliminary Study of the Life History and Habits of Dione Vanillæ Linn.

VANCE RANDOLPH

Some years ago, becoming interested in certain problems connected with the life history of *Dione vanillæ*, I skimmed the scanty literature available, made some observations, and took some fragmentary notes. Having abandoned the study, and being at present occupied with other matters, I am placing this material in the hands of Dr. O. P. Dellinger, to whom I owe my interest in the subject, thinking that perhaps the investigation may sometime be continued by some of his students.

As most of the data was collected near Pittsburg, Kan., all spatial references are to this locality unless some other is specifically indicated.

CLASSIFICATION.

The genus *Dione* Hübner (*Agraulis* Boisduval and LeConte) is confined to the New World. It is classed in the subfamily Nymphalinæ between the genus *Colœnis*, from which it is distinguished by the larger palpi, and the

genus *Argynnis,* from which it differs in the form and venation of the wings. Of its five species only one. *vanillæ* (Linnæus, 1764), occurs in the United States. Of several so-called popular names, two, the gulf fritillary and the red silverwing, are the most common.

Although the above classification is that generally accepted, having been defended for seventy years by "very competent and critical observers," as Holland remarks, there have not been lacking those who, like Müller, would remove *Dione* and *Colænis* from the Nymphalinæ and unite them with *Heliconius* and *Eueides* in a separate subfamily. Müller called these four genera the *Maracuja* (passion flower) butterflies, and his reasons for changing their classification may be stated briefly under nine headings:

1. These butterflies are all found in the warmer parts of America. All the larvæ feed upon the passion flower; no Nymphalinæ larvæ have been found upon this plant.*
2. Eggs all very similar. Has not seen any similar eggs among the Nymphalinæ.
3. Larvæ all very similar. Has not seen any Nymphalinæ larvæ with the same arrangement of spines.
4. These butterflies all feed on flowers; never on sap, like many of the Nymphalinæ. Never seek water on the ground or upon horse droppings, as many of the Nymphalinæ do.
5. These butterflies emit odors. Nothing like this in the Nymphalinæ.
6. Mouthparts all alike.
7. Scent scales on the hind wings of males (except *Dione vanillæ*); no such scales in the Nymphalinæ.
8. The longitudinal veins and the borders of the wings bear on the under surface one or two rows of black hairs. Not found in the Nymphalinæ.
9. The neuration of the wings in all the *Maracuja* butterflies is extraordinarily similar. True *Heliconius* and *Eueides* have a closed, *Colænis* and *Dione* an open cell in the hind wing, but this is insignificant.
   (*a*) The median vein in the fore wing gives off near the base a short (interno-median) spur, running toward the inner marginal (submedian) vein, its point curving toward the border (hind or outer margin). This is wanting in those Nymphalinæ genera for which any claim for close relationship to the *Maracuja* butterflies could be made.
   (*b*) "In the cell of the fore wings there springs from the angle between the median and subcostal veins the stump, more or less long and distinct, of the aborted discoidal." Not found in the Nymphalinæ.
   (*c*) "Not far from the base of the wing the subcostal vein becomes suddenly thinner at a point where its posterior boundary sharply bends in toward the anterior, the latter preserving its direction unchanged. This is the point at which the subcostal formerly divided into its two chief branches, of which the posterior subsequently disappeared right down to its origin from the anterior." Not found in the Nymphalinæ.
   (*d*) "As to the hind wings, I will only remark on the præcostal vein curved toward the base of the wing, which distinguishes the *Maracuja* butterfles from *Acræa,* and also probably from all those Nymphalinæ which may claim to approach them."

"One may well inquire," adds Müller, "how it has been possible that masters of lepidopterology have managed to misunderstand a relationship which, as I

* *Euptoieta claudia* feeds on *Passiflora.* Its range extends, according to Holland, from southern New England to the Argentine Republic. Whether or not it has been reported from Blumenau, in southern Brazil, where Müller's work was done, I do not know.

know from my own family, strikes every child at his first sight of the butterflies on the wing—a relationship which constantly receives fresh confirmation as one learns more and more of their development, life history and structure."

Scudder, in 1899, classed *Dione vanillæ* (or *Agraulis vanillæ,* as he called it) with the heliconians, as have other less eminent American entomologists.

IDENTIFICATION OF THE IMAGO.

The brilliant coloring of *Dione vanillæ* is only approached in this locality by that of *Pyrrhanæa andria,* from which it is easily distinguished even at a considerable distance by the silver spots and the remarkably elongated wings. Its manner of flight somewhat resembles that of the genus *Argynnis,* while that of *Pyrrhanæa* is nervous and *Grapta*-like. The colored plates of Holland, Wright and Maynard are good enough to render identification easy and certain. Of the detailed descriptions of wing markings Holland's is perhaps as good as any

"The upper side is bright fulvous; the veins in the fore wings are black, very heavy near the tips, there are four black spots on the outer border and three discal spots of the same color; there are three irregular black spots toward the end of the cell, pupiled with white; the hind wings have a black border inclosing rounded spots of the ground color; between the base and the outer margin there are three or four black spots; the under side of the fore wings is light orange, the markings of the upper side showing through upon the under side; the apex of the front wing is brown, inclosing light silvery spots; the secondaries are brown, with numerous elongated bright silver spots and patches. Expanse 2 50 = 3.25 inches."

Because of the brilliant coloring of this species, popular literature has come to abound in more or less fanciful descriptions. The following is taken from Winthrop Packard·

" . . . She soared low as if to alight at my feet, and I saw the rich yellow of the upper sides of her aristocratic wings. She hovered and danced up by my eyes, and she seemed robed in shimmering silver, so profusely are the metallic moons scattered over her under wings, and through it all she seemed to blush a vivid red. . . . The lovely, fulvous orange which marks the fritillaries seems in *Dione* to be just a shade richer, but toward the bases of the wings it blushes into a rich wine red, a pellucid crimson, while beneath the after wings are as studded with glittering silver spots as a nautch girl with silver bangles." And so forth.

VARIATION IN SIZE AND COLOR

As Holland has observed, the male is usually lighter in color and less heavily marked than the female. I have come to believe also that the female is usually larger than the male; that those females which emerge early in the season (August) are larger than those females which appear later (October), and that this seasonal variation is much less conspicuous in the male.

Longstaff remarked that his Jamaican specimens were usually smaller and often more brilliant than those from South America. I once fancied, while watching the living butterflies, that those in southern Florida, particularly the males, were more brilliantly colored than in other states, but a comparison of dried specimens some months later showed no difference. There seems to be an almost universal belief among collectors in California that the eastern *vanillæ* is by no means as beautiful as its west-coast prototype, but it seems to me that the difference, if there be any, is very small.

Aberrations are not uncommon. I have never seen an albino, but have

taken two melanic females: one, captured near La Jolla, Cal., was very large, and a sort of muddy, red-olive color; the other, brought in by a small boy at Palm Beach, Fla., was nearly black, the silver spots standing out with a most startling effect.

DISTRIBUTION.

The entire genus being confined to the New World, *Dione vanillæ* has been reported from Mexico, Cuba, Jamaica, Hayti, Porto Rico, Panama, and many points in South America. As to its distribution within the borders of the United States authorities seem to differ somewhat. Holland gives its range as "from southern Virginia southward to Arizona and California." This would practically eliminate Kansas, where I have collected hundreds of specimens, and Illinois, where Mr. W. P. Flint, of the Illinois Natural History Survey, writes me that he "should judge there would probably be about four broods" per annum. If Mr. Flint, by his subsequent statement that *vanillæ* "is well known in all parts of the United States," means that it occurs in all parts of this territory, he is obviously mistaken, and his former statement must perhaps also be discounted.

Maynard confines it to "Arizona and California, but has also been taken at Coalburg, W. Va., Cape May, N. J., and Philadelphia, Pa.," seemingly having quoted from French, who in turn refers to W. H. Edwards, who long ago reported *vanillæ* from Coalburg. An eastern commercial collector of some reputation swears he has taken it in Worcester, Mass., in the middle of July.

In southern California it is abundant the year round, and, in the words of Wright, has become a pest, "as the larvæ feed on the leaves of the passion vine, so the vine becomes a nuisance on account of the caterpillars, and has to be removed." Wright tells us further that *vanillæ* is not native to the west coast, "but was introduced into the country over the Southern Pacific Railroad soon after that was opened up across the interior country to New Orleans, about 1885."

Knowing that *vanillæ* is more common in Oklahoma and Arkansas than it is here, and much less so in northern Kansas, I am inclined to regard southern Kansas as the approximate northern limit of its usual range.

FEEDING HABITS OF THE BUTTERFLY.

As Müller long ago pointed out, *vanillæ* feeds upon the nectar of flowers exclusively. Muller remarked its fondness for a certain poinsettia in his Brazilian garden; in this vicinity preference is given to the cultivated salvia (*S. splendens*) and to a wild purple ironweed (probably *Vernonia noveboracensis*). *Vanillæ* never sucks water from mud and slime, as *Colias, Catopsilia, Terias* and others are so prone to do; never feeds upon the sap of trees, like *Vanessa* and *Grapta,* or upon the ordure of dogs, like *Pyrrhanæa.* Those which I have kept in captivity were never seen to take any food or to alight upon any of the blossoms available, including the two favorites above mentioned. No attention was paid to the dried-apple-and-sugar preparation made famous by Mr. W. H. Edwards.

THE NUMBER OF BROODS.

In the tropics, of course, it has many broods and breeds continuously. Several westeners have told me that this is true also in interior California. Wright says that it flies "at all times and all seasons" near Los Angeles; this

is the case also in southern Florida, although it is much less abundant during the winter months. Mr. Flint writes me that there are "probably at least six or eight broods" in California, and adds that he "should judge that there would be about four broods in Kansas, and probably about the same number in Illinois."

As to the number of broods here (Pittsburg, Kan.) I am still in doubt. I have found eggs as early as July 20 and as late as September 28, full-grown caterpillars as late as October 25, chrysalids from August 10 to November 21, and butterflies from August 1 to November 28. Between August 1 and September 10, eggs, larvæ of all sizes, pupæ and adults are all comparatively abundant, the imago, however, never becoming as common as one would suppose from the number of caterpillars taken

Another thing. For six seasons past male butterflies have each season appeared a week or ten days before a single female could be found. It is of course quite possible that the further accumulation of data will show this to be purely coincidental.

DOES VANILLÆ HIBERNATE?

"Every year," according to J. W. Folsom, "some of the southern butterflies reach the northern states, where they die without finding a food plant, or else maintain a precarious existence" Dr W T. M. Forbes writes me that he believes that *vanillæ*, in its northern extremes, "occurs only as a stray, not surviving the winter."

I had previously assumed that the winter is passed in the larval state, as in the case of *Euptoieta claudia*, but have since come to suspect that *vanillæ* does not hibernate at all I cannot believe that the egg weathers the Kansas winter, because I have never been able to find it later than September 28, and because the butterfly does not appear until about August 1 of the succeeding year As to the caterpillar, those which I have reared always pupated or died before November 1; besides, a most painstaking search in the vicinity of the food plant has failed to uncover any during the winter. Of some twenty belated chrysalids not one survived the winter of 1917-'18, although several butterflies emerged as late as November 21. and as no living pupæ can be found during the winter, it seems to me most improbable that the chrysalis hibernates in this locality. The fact that the imago does not appear until August 1, the earliest specimens being fresh and in good condition, surely indicates that the winter is not passed in this stage.

On the other hand, I can offer no explanation of the fact that for three consecutive seasons half-grown caterpillars have been discovered some days before I have been able to find either egg or butterfly.

THE SO-CALLED OFFENSIVE ODOR.

Besides several references to "that beautiful but ill-smelling fritillary, *Dione vanillæ*, "Longstaff reports that in Jamaica, in 1907, he examined seventeen males, thirteen of which exhibited an odor varying from very faint to very strong, and invariably offensive. He describes it as "like a stable, like asses, like cow dung" Mrs. Longstaff used the terms "offensive" and "unpleasant," and a Mr. Abell pronounced it "musky." Fritz Müller writes:

"The males, . . . when seized, open wide the anal valvulæ, from the inner side of which there appear two glands yielding a strong and nauseous

smell. The females, on the contrary, emit a similar smell from a yellow gland extruded on the dorsum between the last and penultimate segments."

Similar organs and odors occur in *Heliconius* and allied genera; these are fully treated in the voluminous literature dealing with Bates' theories of mimicry. Bates, Darwin, Wallace, Belt, Trimen and others long ago observed that these butterflies and others superficially resembling them were immune from the attacks of tropical spiders, dragonflies, birds and monkeys, and that mounted specimens of the Heliconidæ in particular were rarely molested by vermin. Wallace concluded that this immunity is due to "a strong, pungent, semiaromatic or medicinal odor, which seems to pervade all the juices of their system." Wilson says that this odor reminds him of that of the muskrat, and even of "the still more awful effluvium of the American skunk." Holland remarks that certain butterflies (notably the Euplœinæ) are distasteful to birds and predaceous insects, adding that this is "probably due to the character of the plants upon which the caterpillars feed, for many of them eat plants which are more or less rank, and some of them even poisonous to the higher orders of animals." It is interesting to note, in this connection, that *Passiflora incarnata,* upon which *Dione vanillæ* feeds, is by no means rank or poisonous In the Southern states the fruits are called maypops and are commonly eaten by children, and, according to Ballou are highly esteemed as food in South America, Australia and New Zealand

Personally I am unable to detect any characteristic ódor about these butterflies, my olfactory sensibility being obtuse. Calling in nine of my friends, however, I find that all of them are able invariably to distinguish, blindfolded, between the sexes, all agreeing that the male emits a very distinct odor. None detected the odor ascribed by Müller to the female, although the "yellow gland extruded on the dorsum" is very conspicuous. None thought the odor especially unpleasant, as did Longstaff and his friends; none would accept Müller's term "nauseous" as properly describing it. "Sweetish, musty, pleasant, spicy, musky, like bees, like daisies"—these are some of their descriptions.

I have myself tasted freshly killed specimens of both sexes, crushing the bodies between the teeth and holding them in the mouth for some time. The taste is unpleasant, but not at all violently so, reminding one of the taste of the seeds of the common sticktight (*Bidens frondosa*). I was unable to detect any difference between the sexes in this regard. Have been unable as yet to check these results against the experience of others, my available observers having refused their services.

Very little seems to be known about the actual functioning of this odor as a protection against birds and other enemies. Personally, never having seen a butterfly of any species pursued or captured by a wild bird, I incline to the view that the number destroyed by birds, in temperate America at least, is inconsiderable. The lack of butterfly remains in the thousands of bird stomachs examined by McAttee, Forbes, Kalmbach, Beal, Weed, Dearborn and others is significant. David Sharp says, in criticising Bates' theories, "It has not been found, as a matter of fact, that even unprotected butterflies are much destroyed in the perfect state by birds." Men like Marshall, Jones and Poulton, however, regard birds as the chief enemies of butterflies, while Frank Finn, whose work was done in India, writes: "There is a general appetite for butterflies among insectivorous birds, even though they are rarely seen, when wild, to attack them."

THE ALLEGED ATTRACTIVE ODOR.

Besides the offensive odor emitted by the abdominal scent organs, Müller held that the males of this and other allied genera are supplied with another and quite different perfume, which is attractive to the female of the species. He believed this odor due to the functioning of scent scales (*Duftschuppen*) on the fore wings.

The peculiar character and arrangement of the scales along veins one to six, inclusive, in the fore wings of the male is apparent to anyone without the aid of a lens, and affords a convenient means of distinguishing between the sexes at a glance. Scales of this nature have been known since Bernard-Deschamps, who for some reason called them plumules; some later lepidopterist—Scudder, I believe—has given them the better name, androconia. Thomas, writing in 1893, described these scales as hollow tubes connected with glands, and thought that matter secreted by the glands passes out through the scales and becomes diffused.

Scudder, it appears, made no distinction between the two very different odors described by Müller, for he remarks that it has never been proven that any odor produced by the male attracts females, and hints that the function of the androconia is perhaps mere ornament. Referring, in 1880, to butterflies in general, he writes. "The location of the scent organs has never been properly attempted. It is idle to suppose that in so small a creature one may fix the region of the body where they belong by such rude tests as merely smelling of various parts, as Fritz Müller and his family have done," adding that the organs will probably be found on the body near the end of the abdomen.

That the odor perceived by my observers has no connection with the scent scales I have proven by cutting off the wings, when the quality and intensity of the odor were in no wise altered or diminished. I have also tried the effect of presenting these wings before blinded females, with negative results. This latter means very little, however, as I found it inexplicably difficult to get these butterflies to copulate, or indeed to exhibit any indications of sexual excitement in captivity.

As Sharp has pointed out, "in nearly all Lepidoptera it is the male that seeks the female." This being the case, it seems improbable that the so-called scent scales, occurring only in the male, are of any great importance in mating.

OVIPOSITION.*

"One of the females, alighting upon the upper side of a leaf within ten inches of my face, suddenly elevated the forward part of the body, brought the wings together vertically, curved the abdomen slightly forward, and drew its tip slowly across the surface of the leaf for a distance of approximately 12 mm. Remaining quiet for an instant, it lifted the abdomen, showing the egg firmly attached to the leaf. The eggs are laid singly, usually in the upper middle of one of the three lobes of the leaf. I have never seen more than one upon the same leaf." (August 5, 1917.)

THE EGG.

"The egg measures about 1.2 mm. in height and .7 mm. in diameter at the widest part, barrel-shaped, with fourteen vertical ribs. A brilliant yellow at first, it assumes after about thirty-six hours a reddish-brown color. A few

* This and succeeding dated and quoted paragraphs are copied without revision from my daily notes.

hours later an irregular, whitish broken ring, not quite circling the egg, appears about one-third of the distance from the top. When within an hour or so of hatching the shell becomes very thin and transparent and reflects the light with a sort of frosted-glass effect. The large black head of the larva inside gives the upper one-third of the egg a black, metallic appearance, while the yellowish body may be seen curled up in the lower part. The incubation period seems to vary greatly with the temperature, from forty-seven hours (August 7, 1917) to seven days." (September 22, 1918.)

THE EMERGENCE OF THE CATERPILLAR.

"At 2:15 p. m. the larva was clearly visible through the shell Slight bodily movements were noted, then the very large, shining black head was thrust out at a point on one side of the egg, just below the top. The entire structure rocked and swayed slowly back and forth, inclining toward the side from which the head projected.

"At 2 19 the larva emerged very slowly, head first. The head and the final segment appeared very large. The entire length was about 1 5 mm The body yellowish red; prolegs and caudal segment lemon yellow, the head, legs and spines black The latter bear no visible branches, and appear as stiff, black hairs, each growing out of a slight black protuberance.

"The beautiful eggshell remains erect, the form being unchanged There is a ragged hole in it, but it is scarcely noticeable, and appears hardly large enough for the egress of the caterpillar" (September 22, 1919.)

THE CATERPILLAR.

"The newly emerged larva does not venture far from the eggshell and does not move about much for the first five or six hours It sometimes devours the shell, but this is not usually the case. At the age of six hours it appears darker, and the black spots from which the hairlike spines protrude have become more conspicuous. Has not eaten any of the leaf, and has increased in size very little if at all" (September 20, 1917)

"At the age of twenty-seven hours the larva attains a length of 2.3 mm and has eaten several small holes in the center of a large leaf, gnawing through the leaf to the transparent epidermis on the opposite side, which is left intact. Usually works from the upper side, but by no means invariably." (August 10, 1917.)

"These smaller larvæ seem to be always attached to the leaf with silk, although the threads are very few and fine. More mature larvæ feed differently; they grip the petiole with the prolegs, and eat from the edge inward and forward, swinging the head toward the midrib, with practically no lateral motion." (September 1, 1917.)

"The caterpillar is cylindrical and bears six rows of black, branching spines, twelve in each row. As regards color, there are, besides the reddish, newly hatched type described above, two well-defined types the orange drab and the drab orange In the first the body appears orange with three narrow drab stripes, and a very narrow lateral line just above the prolegs In the second the drab markings become very much more prominent, so that the body now appears drab with four narrow orange stripes. The narrow drab dorsal line of the younger caterpillar becomes very conspicuous in the mature larva, separating the dorsal surface into two distinct orange areas. As the orange-drab type seems to embrace all of the smaller larvæ, and as all those about to pupate belong to the drab-orange type, I have assumed that the color change is a matter of maturity. Whether the change comes gradually or is the immediate result of moulting I do not know." (September 10, 1918.)

"The mature caterpillar," says French, "is 1.5 inches long, of a red-orange color, with a broad dorsal line of greenish black and a broad slate-black band outside this reaching to the first lateral, except a narrow stripe of the ground color. Base slate black, orange through the region of the spiracles."

I can make nothing of this description. The mature caterpillars which I have reared were invariably of the drab-orange type described above. I have

collected these larvæ in Kansas, Missouri, Oklahoma, Arkansas, Tennessee, Louisiana, Florida and California, and have seen specimens from several other states and from Mexico. Of these the larger larvæ (which I take to be the more mature specimens) were always of the type which I have called the drab-orange.

MISTAKEN IDENTITY.

"The only caterpillar which is likely to be confused with *Dione vanillæ* is that of *Euptoieta claudia.* No other larva of similar appearance feeds upon *Passiflora* in this region. The general outline is much more slender than in *vanillæ,* the two head spines are knobbed at the ends and are straight instead of incurved, and the spines are steel blue instead of dead black. The color scheme is approximately that of the orange-drab type, but the stripes are whitish yellow rather than drab, and broken instead of solid The head is less prominent than in *vanillæ,* and lacks the black visor markings so conspicuous in the latter These larvæ seem to appear at about the same time as *vanillæ,* but are less abundant, although the butterflies are common enough from the middle of July to October *Claudia* undoubtedly passes the winter in the larval state, while *vanillæ* probably does not hibernate at all in this locality. The *claudia* caterpillar feeds sometimes upon violets, and perhaps other plants, while *vanillæ* is found only upon the passion vine The chrysalids are very different, that of *claudia* being nearly white" (August 10, 1918)

MOLTING.

"11 30 a. m—Larva about 21 mm, inactive and very dark, extended on lower side of leaf, front of body high, head bent, holding with third, fourth and anal prolegs. A few silk threads lie flat on leaf near caudal end of body. After some little rippling of muscle (no violent motion) the skin of the body separates from that of the head. The former is very tight, slowly, segment by segment, it is skinned backward until finally it is left, a crumpled, prickly black ball about 4 mm. in diameter, fastened to the leaf by the aforementioned silk Meanwhile the head covering, which is all of a piece and bears two large spines, slips forward until it appears to be held in the mandibles as a hat might be held between the teeth After a moment it falls to the ground. The caterpillar now appears somewhat short and a trifle thickened. The head, legs and prolegs are yellow, the body orange. The spines are only half size, blunt, yellow and semitransparent The branches appear as black hairs lying flat along the sides of the spines.

"11 33 a m—The spines have now attained practically their normal size, springing out with astonishing rapidity. They are still blunt, yellow and semitransparent, but the black branches have reached normal size and assumed their proper position. The two head spines, which were curled backward, have taken on the usual angle. The head, body and prolegs now appear orange rather than yellow, the head being lightest. The drab dorsal stripe has appeared, but is very narrow. The row of depressions, one in the dorsal center of each segment, is much more conspicuous than usual.

"11 50 a.m.—Appears quite normal again, except that the spines are not quite as black, showing grayish toward the tips. The black frontal markings appear. Caterpillar rests motionless.

"12 10 p m—Turns about and begins to devour the cast-off skin. With the lens I watched it begin at the tip of one of the big spines and consume it clear to the root, apparently in about three mouthfuls. The head covering is never eaten.

"12·30 p.m.—Skin practically consumed. Larva rests motionless, a few of the surplus spines resting beneath the head and thorax." (September 10, 1918.)

PUPATION.

"10 00 a.m.—Caterpillar, 37 mm. long, leaves food plant and begins to wander restlessly about.

"1:00 p.m.—Extended motionless, clinging to under side of window frame.

"2:30 p.m.—Same position.

"3:30 p.m.—Begins to lay a sparse, ragged network of very fine threads flat to the surface, covering a space of perhaps an inch square. These threads thin toward the periphery of the net, where they are hardly visible without a lens.

"4:00 p.m.—Spins a little white silk button in the center of the network. The head moves slowly out horizontally in all directions from the button about one-half inch, swinging always back to center. The body is fully extended, the abdomen being away from the button.

"4:30 p m —Interrupted the button-making to raise high the caudal third of the body, spreading the anal appendages apart several times. When a pellet of excrement appeared, the caterpillar turned about and pulled it out of the foramen ani with the mandibles, holding it thus a moment before allowing it to fall to the floor.

"4·45 p.m —Resting, body extended, clasping the button with the third prolegs

"6 00 p.m —Fastened to the button. The body is extended horizontally, clinging to the under surface of the window frame with the prolegs; head drawn back, legs not touching the surface.

"8 00 p.m.—Hanging from the button. The body is thickened a trifle and shortened to 31 mm. Color much lighter; hangs motionless except for very slight movements of the legs and prolegs." (September 4, 1918.)

"9·00 a.m.—No change.

"10.00 a m.—The brilliant colors have practically disappeared, leaving the body a pearl-gray color, against which the black spines show up with startling distinctness. Movements slight and infrequent. The dorsal thorax is now the lightest part of the body.

"11·00 a.m.—Begins to wriggle a little.

"11 10 a.m.—I note that the spines appear closer together at the caudal and of the body; then see that the skin has split down the back and that the light-colored head of the chrysalis is protruding. By a series of vigorous wrigglings the skin is slowly forced up to where the tip of the abdomen is attached to the button. Then comes the violent struggle which finally loosens the skin, which hangs for a moment against the ventral abdomen, then falls to the floor. Then entire molt is complete in less than five minutes" (September 5, 1918.)

THE CHRYSALIS.

When the chrysalis first appears it is nearly cylindrical; no dorsal depression, no ventral bulge. The head is bent forward, and the whole thing has a compact, sluglike appearance. An hour or so later the head is no longer bent, and bears two double projections, set wide apart; the wing cases are bulging and prominent; on the dorsal side, opposite the middle of the wing covers, is a U-shaped depression; there are projections on the third, fifth, sixth and seventh abdominal segments, those on the third being the largest. At first the head, thorax and wing covers are translucent and nearly white; the abdomen is a little darker and bears a ventral bluish stripe on the fourth, fifth and sixth segments. The four pairs of dorsal protuberances are amber-colored.

An hour later the head and thorax darken somewhat, and opaque whitish veins appear in the wing covers. Distinct black lines mark the outer borders of the fore wings, and a black V-shaped mark shows the position of the larger of the three discal spots.

Another hour and the translucent appearance is gone, the abdomen and the dorsal thorax become much darker, the wing covers grayish tan, while the bluish ventral stripe turns gray or white.

From this time forward the chrysalis does not change appreciably in form

or color (although the latter varies greatly) until about twenty-four hours before emergence, when the entire body becomes very dark.

French finds a very wide variation in color: "Some specimens buff with greenish markings, or on the abdomen greenish brown; some black, the wing cases and anterior parts mottled with light and dark black; some with the anterior parts pink tinted, mottled with greenish black."

The average length of the chrysalis is 28 mm. and the white ventral stripe is usually the most conspicuous marking. After the butterfly has emerged the color variations of the chrysalis still persist in the empty shells, some being much darker than others.

Not infrequently the cast skin of the larva is found attached to the anal portion of the chrysalis. This skin is black excepting the head, which is gray, and the black branching spines loom large because of the contraction of the empty skin.

Sometimes the chrysalids turn bright yellow; these are usually infested by parasites. I have opened many of these pupæ, but have never found the parasitic larva itself; the pupæ and adults I have often taken, the latter being a small (2 3 mm), green hymenopterous insect which I have not as yet had the opportunity to classify. Some ten or a dozen of these insects emerge from a small round hole, usually in the wing cover, in early August. (September 3, 1918.)

PUPAL MOVEMENTS

"The chrysalis seems unable to bend the body toward the back or toward the wing covers; sidewise, however, it can turn until the body is extended nearly parallel to the horizontal surface from which it is suspended. Six chrysalids which hung in a north window in September, 1919, and which I observed for fourteen days, were noted to be invariably and unanimously pointed inward (toward the warm room, that is) every morning. During the warmer part of the day there was no uniformity in position. Six specimens—fourteen days, it appears to be more, perhaps, than mere coincidence. The pupal sensibility to light and temperature stimuli should be worth investigation." (October 1, 1919.)

THE APPEARANCE OF THE BUTTERFLY.

"Two or three weeks after pupation (the period varies with the temperature, from eight days in August to twenty-seven days in November) the chrysalis turns nearly black, and a diagonal fissure appears on either side, extending from the back of the head down along the antenna cases, nearly to the middle ventrum.

"About twelve hours later, after some little wriggling, the ventral triangle formed by the covering of the head, antennæ and mouth parts falls open trap-door fashion, the antennæ covers serving as hinges and the flexing point being about one-third of the distance up the wing covers from the abdomen. There is also a dorsal cleavage following the medial dorsum to the first abdominal segment, then the outline of the wing covers to a point half way to the end of the antenna covers. The crumpled-wing imago wriggles out and mounts the empty shell, to which it clings by the four hinder limbs, turning the entire body back and forth as if mounted on a pivot. In each of these turns the body describes an arc of nearly 90 degrees, the body being held stiff. The angle of the body is about 45 degrees from the vertical, the head being uppermost. The proboscis is usually partially unrolled. In five or six hours the soft, wrinkled wings spread and harden, and the insect is able to fly. A thin, transparent liquid, and sometimes a thick, reddish substance, are voided by the newly emerged butterfly. Both of these liquids seem to be odorless." (October 5, 1918.)

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A Kitchen Disinfectant.

F A PATTY and L E SAYRE

During the period of the invasion of influenza every possible source of and every possible means for spreading contagion were sought for and checked by the Board of Health. One of the suspected possible sources of communicating the contagion was that of soda-water tumblers. Many dispensers of soda water employed paper tumblers; others installed running water at scalding temperature; others used steam; and still others employed an adequate sterilizing apparatus at considerable expense. But the majority of stores, whose business, in small towns, was comparatively small, and for other reasons were unable to adopt either method. Accordingly, the Board of Health requested the department of pharmacy to devise a sterilizing bath that would accomplish the purpose at a minimum of expense, so that it would be within the reach of every retailer. It was suggested by one of us that a sodium hypochlorite solution bath would be quite sufficient for the purpose of cleansing and disinfection, but this was merely a statement. In order to verify such

a result it was necessary to take up the subject in a scientific way and perform experiments with solutions and note their effect upon tumblers that were intentionally infected.

Laboratory experiments to cover the situation were accordingly designed and carried out. This was accomplished by first procuring cultures of three organisms. One was a culture of *Micrococcus aureus,* an organism which produces boils and abscesses and is found abundantly in the mouth and throat. It is relatively easy to kill. Another was a culture of typhoid bacillus, the bacteria causing typhoid fever. Last was a culture of *Streptococcus pyogenes,* which causes sore throat and various skin eruptions. This organism is very resistant and difficult to kill with ordinary disinfectants.

Broth cultures of these organisms were prepared and incubated twenty-four hours at body heat to obtain a luxuriant growth, then poured into glasses, previously sterilized in an autoclave. The glasses were drained, one at a time, dipped into a disinfectant bath and removed immediately. Each glass was next rinsed with sterile broth and a portion of the broth streaked on agar and incubated at body temperature to ascertain whether or not the organism had been killed by the disinfectant bath

The time element in this way is reduced to a minimum, but so would it be in actual practice. Many solutions can be prepared which will be good disinfectants if allowed to remain in contact for some time and at a temperature somewhat above room temperature (72° F.).

An extract from the tabulation of experiments with various solutions, together with results obtained, is herewith subjoined. It may be of interest to note here that results obtained from some solutions were somewhat surprising, as will be indicated

The calcium hypochlorite solution employed was made by triturating bleaching powder with water and straining the mixture. The sodium hypochlorite solution used is best made as directed in making solution No. 1.

FORMULA

SOLUTION No. 1. Triturate 200 grams bleaching powder to a smooth paste, using 400 cc. water, and wash into 2-liter flask with 200 cc. water Add 140 grams pure sodium carbonate dissolved in 250 cc. hot water. Shake thoroughly; if contents become gelatinous, warm Transfer to a wetted muslin strainer in a funnel and return first portion of filtrate until it comes through clear. Drain and wash with small successive portions of water to make 1,000 grams of the solution

Use 10 cc of solution No. 1 to make 1 liter disinfectant bath.

SOLUTION No. 2. Measure exactly 69 cc. c. p hydrochloric acid (sp. gr. 1.17) into a liter flask and make up to a liter with distilled water.

Use 10 cc. to each liter disinfectant bath in final preparation for use.

PRECAUTIONS. All weights and measurements must be made *exact* for maximum results. Distilled water must be used in making solutions 1 and 2, and preferably, but not necessarily, in making the final bath. The bleaching powder must have at least 30 per cent available chlorine present. The most favorable temperature for the bath is between 80° and 95° F. (27° and 35° C.). Solutions 1 and 2 keep indefinitely in glass-stoppered containers.

The method of application is simply to dip the previously washed glass

into the bath, allowing all parts to come in contact with the liquid, and sterilization is complete. The bath is harmless to the hands.

It must be generally understood that no disinfectant, no matter how efficient, can so readily disinfect a dry, dirty glass. The particles of dirt (organic matter) envelop the organisms and form a protective coating. To illustrate the truth of this statement, glasses infected by a broth culture of *Streptococcus pyogenes* were allowed to dry spontaneously, then dipped twice in quick succession into bath 18, and when streaked on agar the organisms were found to be alive. Therefore, after use at fountain, glasses must not be permitted to become dry, but should be preferably rinsed in tap water before going into the bath. This precaution would also help to maintain the efficiency for a longer period than otherwise would be possible. Care must be taken not to increase alkalinity by careless addition of wash water. Glasses are to be rinsed with clean water after the disinfecting bath.

Our report to the board tabulated a long list of solutions of various compositions and the constitution of the baths made therefrom. It is not essential that this paper shall be burdened by this lengthy tabulation, but the essential points may be condensed. It was found that the maximum disinfectant power was to exist between six different solutions, as follows:

Disinfectant Bath	Organism	Killed		Growth inhibited.
		Fresh bath	Bath 24 hours old	
Exp. 14: Sodium hypochlorite solution 0.04 per cent available chlorine nearly Neutralized with hydrochloric acid	Micrococcus aureus	−	−	+
	Typhoid bacillus	+	−	+
	Streptococcus pyogenes	−	−	−
Exp. 15. Sodium hypochlorite solution 0.05 per cent available chlorine	Micrococcus aureus	−	−	−
	Typhoid bacillus	−	−	+
	Streptococcus pyogenes.	−	−	−
Exp. 16: Sodium hypochlorite solution 0.1 per cent available chlorine	Results same as for 15			
Exp. 17: Sodium hypochlorite solution 0.05 per cent available chlorine + 50 cc N_{10} HCl per liter	Micrococcus aureus	+	+	+
	Typhoid bacillus	+	+	+
	Streptococcus pyogenes	−	−	+
Exp. 18: Sodium hypochlorite solution 0.05 per cent available chlorine + 80 cc. N_{10} HCl per liter	Micrococcus aureus	+	+	+
	Typhoid bacillus	+	+	+
	Streptococcus pyogenes.	+	+	+
Exp. 19: Sodium hypochlorite solution 0.05 per cent available chlorine + 120 cc. N_{10} HCl per liter	Micrococcus aureus	+	−	+
	Typhoid bacillus	+	+	+
	Streptococcus pyogenes.	+	−	+

It should be stated, in passing, that hot water was found to be not at all satisfactory unless considerable time be allowed for the glass to macerate therein.

A simple solution of sodium hypochlorite, rather unexpectedly, was not efficient.

In an effort to produce a sodium-hypochlorite solution less alkaline, and consequently more efficient, solution No. 1 was made up by four different

formulas, using less sodium carbonate, and baths of 0.05 per cent available chlorine made from them, but all proved unsatisfactory.

Bath No. 18 was repeated with the same good results, and was found to be germicidal to micrococcus aureus and typhoid bacillus, even after standing seven days. A liter was then tried on 150 glasses in a series and found to be efficient for that number. Although this bath under good conditions is germicidal more than twenty-four hours, it is strongly recommended that it be prepared fresh each day.

It may be noted in the experimental data that the hot water is not at all efficient in the time allowed. By comparing the results it can be seen that a 0.06 per cent available chlorine solution is of little more value than a 0.04 per cent solution. A strong alkaline solution appears to be as good the second day as the first and to be as powerful as a neutral solution. The sodium carbonate tends to hold the chlorine in solution. A solution made acid with hydrochloric acid is strongly germicidal when freshly prepared, but of no value after standing twenty-four hours, because the chlorine is liberated and soon escapes from the solution. Sodium salicylate, germicidal in itself, appears to add no power to the hypochlorite solutions.

The unneutralized sodium hypochlorite solution proved to be of no value even in a strong (0.1) available chlorine bath This was a revelation very disappointing, to say the least. The idea of reducing the alkalinity suggested itself. Therefore, varying amounts of N/10 hydrochloric acid, sufficient to neutralize the solution, were added to baths 17, 18 and 19. The results were somewhat striking, in that it was found that the maximum results were obtained, as will be seen, in the mean between 17 and 19; namely, in 18.

CONCLUSIONS

1. It will be seen from our report to the State Board of Health that nineteen different solutions of various compositions were experimented with. The solutions containing available chlorine were the only ones that were available for making a disinfectant bath. Of the various sodium hypochlorite baths tested it was found that the amount of free chlorine was not the only factor that determined efficiency. For example, a bath containing 0.1 per cent of available chlorine was no more efficient than one containing .04 per cent or .05 per cent.

2. The efficiency of the hypochlorite bath seems to depend not only upon the available chlorine, but also upon the degree of alkalinity of the solution. The most efficient solution seems to be that containing .05 per cent of available chlorine and a degree of alkalinity represented by almost the neutral point. In order to determine the exact amount of alkalinity, an aliquot portion of the solution neutralized with its equivalent of HCl (the amount designated in formula 18) was evaporated to dryness, the residue redissolved in distilled water, and the resulting solution titrated. It was found that 1 cc. of the original solution thus prepared corresponded to 5.0 cc. of N/10 HCl. Since 10 cc. are used in a liter of bath, the alkalinity of this would make a liter of the bath correspond to 50 cc. N/10 HCl.

3. This solution of the above alkalinity can be arrived at by using the proportions indicated in formula 18, using the solutions and mixing same as prescribed in said formula.

4. Since one of the microörganisms resisted the boiling-water bath and only two were inhibited in growth, therefore it would seem that any treatment with boiling water—much less warm water—would be absolutely unreliable unless care was taken that the utensil was permitted to remain in such a bath for some minutes. It is also suggested that the wiping of the cleansed tumbler with a fabric would be objectionable, for the reason that repeated use of same would tend toward a risk of contamination.

5. There are a number of proprietary disinfectants on the market containing available chlorine. Some of these are valuable, but their value should be estimated by the percentage of available chlorine present, but only by a coefficient biologically determined.

KITCHEN DISINFECTANT.

The above solution, it is needless to say, would be a very valuable solution as a household disinfectant, or, as we have chosen to term it, a kitchen disinfectant. It is a deodorant as well.

Besides being applicable for disinfection and purification, it may be employed as a bleach in the wash water, and is not injurious to the fabric.

It should be stated that the formula for the preparation of this disinfectant is, perhaps, rather intricate and beyond the ability of the unskilled to follow. The formula, however, can be readily followed by one of very ordinary ability in manipulation, so that its manufacture would not be at all expensive.

[NOTE.—Plant Disease Survey Report for Kansas, 1919, by L. E. Melchers, withdrawn.]

PART IV.

PAPERS—FIFTY-THIRD ANNUAL MEETING.

TITLES OF PAPERS,

FIFTY-THIRD ANNUAL MEETING.

PUBLIC BATHS AND THEIR HYGIENIC OR SANITARY VALUE. *J M McWharf.*
COLOR IN NATURE. *J. E. Todd.*
A NEW NESTING RECORD FOR THE PINE SISKIN. *F. F. Crevecoeur*
ADDITIONS TO THE LIST OF KANSAS LEPIDOPTERA. *F. F Crevecoeur*
ADDITIONS TO THE LIST OF KANSAS HYMFNOPTERA. *F. F Crevecoeur.*
NATURE'S USE OF DISINFECTANTS AND ANTISEPTICS *L E Sayre.*
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ARCHÆOLOGY OF THE TUBA-KAYFNTA REGION. *Albert B Reagan*
SOME NOTES ON THE LUMMI-NOOKSACK INDIANS, WASHINGTON *Albert B. Reagan.*
FLOOD MYTHS OF THE BOIS FORT CHIPPEWAS *Albert B. Reagan*
HUNTING AND FISHING OF VARIOUS TRIBES OF INDIANS. *Albert B. Reagan*
FROGS AND FROGGING. *E C. O'Roke.*
THE INDUSTRIAL RESEARCH MOVEMENT OF TO-DAY. *W F. Faragher.*

Public Baths and Their Hygienic or Sanitary Value.

J M McWharf.

Public baths mean a long step toward hygiene, sanitation and national hygienic uplift. Hygienic measures are as old as the history of creation; to-day we have a more general recognition of their importance. The rapid progress of knowledge, the marvelous increase of humanity and human power over the elements and agents of nature, by means of applied science, the requirements of humanity and experiences, one and all, combine to make the duty and practicability of sanitary regulations an important factor in our lives.

Lord Palmerton, when asked to procure a royal order for a national fast in anticipation of cholera, said: "The best course which the people of this country can pursue, that the further progress of the cholera should be stayed, will be to employ the interval that will elapse between the present time and the beginning of next spring to planning and executing measures by which those portions of their towns and cities which are inhabited by the poor classes, and which, from the nature of things, must need purification and improvement, may be freed from those causes and sources of contagion which if allowed to remain will probably breed pestilence and be fruitful in death, in spite of all the prayers and fastings of a united but inactive people." A well-conceived and forceful suggestion. The best minds of the world have striven to lighten the burden of the poor and oppressed. Millions have been offered for a cure of disease, but efforts for its prevention have received tardy recognition. Experience teaches that personal cleanliness occupies the foremost rank in our consideration.

This nation is not keeping pace with the Jews, Egyptians, Greeks, Turks and the Brahmans. John Wesley recognized the civilizing influence of soap and water when he said, "Cleanliness is next to godliness."

Tacitus states that the ancient Teutons were accustomed to bathe as often as they arose. The Romans were imitators of the Greeks, but eventually surpassed them and all other nations in the extent of their baths. The excavations at Pompeii, A. D. 1824 and 1857, furnished us with an exact and realistic representation of the Roman baths; their convenient, luxurious appointments and artistic embellishments. During the time of Constantine, Rome boasted of having 856 public baths. The price of admission then averaged about one-third of a cent. Pliny, in his "Historia Naturalis," asserts that for 600 years Rome needed no medicine but the baths. Is it not a sad commentary upon our boasted civilization that we do not imitate those people and emulate their generosity in supplying the people with means to keep their bodies clean. We speak of those people as ignorant and barbarous, but they erected large public baths for use by the poor people.

In the fourteenth century nearly every village or town in Russia had its bathroom. A large per cent of the villages had vapor baths. This was first used; then the subjects were scrubbed with soap and water, followed by a form of massage, concluding with a thorough shower bath. In Yeddo a public bathhouse is visible at every hundred steps. Contrast these conditions with those that we usually find in our own country.

If we get a supply of water necessary to wash the hands and face from one to three times each day it is considered all that is necessary. The clothing will hide whatever of dirt that might accumulate on the rest of the body. The filthy condition of the poor is responsible to a large degree for the spread of many diseases. The so-called tenement odor, which so often offends the sensitive olfactories in crowded street cars and other assemblies of the poor, emanates from the decomposed secretions of the skin which have accumulated upon their persons and found lodgment in unventilated clothing. There is a moral obligation resting upon the wealthy portion of a community to contribute freely toward the removal of this remediable evil, uncleanliness. Modern hygiene has demonstrated that the essential principles of sanitation lie in cleanliness.

We have also learned that the great panacea for the prevention of disease and premature death is in pure food, water, air, clothing, and the houses in which we live.

Doctor Mittman has shown that the crescents which adorn the finger nails of uncleanly people, their hair, skin and clothing abound in saprophytes, and that the lives of these parasites are imperiled by cleanliness and that they thrive only in filth. Every intelligent man knows that personal cleanliness is an important element in the health problem.

Personal cleanliness, so vital as a hygienic measure, must be carried to the forefront in our battle for a more perfect sanitation. Perfect compliance of all classes of people with sanitary laws will aid materially in the prolongation of human life and lessen sorrow and suffering in the world.

No argument is required to prove the necessity nor the present demand for public baths and no efforts should be instituted to thwart so great a public beneficence. Prompt action is demanded along this line of humanitarian work. Cleanliness means health; it means preservation of life; it means moral improvement; it means an uplift to all that is good and pure in the world.

Color in Nature.

J. E. Todd.

Light, like sound, consists of vibrations capable of producing a conscious impression upon sentient life. In sound they are of ordinary matter, usually air, appreciated mostly by the ear. In light they are much more delicate and mysterious vibrations of ether, which affect the eye. Color is a property of light, dependent upon the length or rapidity of such vibrations, just as pitch is a quality of sound in a similar way.

As there are soundlike vibrations which are inaudible, so there are many waves of lightlike vibrations which are invisible. Moreover, as sound may be pitched too high or be too faint for one to hear, and yet be enrapturing melody to another, so doubtless some organisms perceive delicate colors which are invisible to man. Our subject is too vast for us to consider more than the infinite variety of patterns and tints which appeal to the human eye in nature.

CAUSES OF COLOR.

Color, from a physical standpoint, is an accident or coincidence. It is simply the result which follows from the relation of the dimensions of molecules, or masses, to the length of ethereal waves. Colors may be classified, from their causes, into absorption colors, interference colors, and refraction colors.

Sunlight, or any white light, consists of all kinds of color waves mingled together. If these fall upon any object whose ultimate particles or molecules correspond in size to the length of any particular color, as red, for example, so that they begin to vibrate in harmony with the red wave, such vibrations are said to be absorbed, and change to heat, chemical or electric vibrations, as the case may be. In such conditions the waves not so absorbed, which give the sensation of green, would be reflected from the surface, and the object would be called green. So with the absorption of any other color or colors by a pigment or any object. Under this head come the great majority of colors in nature.

In the case just mentioned light is reflected in a radiant manner from all points of a substance; in other cases, where the surface is smooth, the reflection is like that from a mirror. As light strikes the surface of a thin, transparent film a portion is reflected and a portion enters it and is reflected from the opposite surface. If the surfaces are at such a distance that the wave lengths of a certain color interfere, that color is destroyed, and only the color waves not so destroyed will be visible. If red is destroyed the rest of the light will be green, and the film at that point appear green.

Again, if light falls upon striæ or thin lamina similarly related to the length of light waves, interference may also occur and similar results will follow. As an example of film interference we may refer to the colors of a soap bubble, or of oil upon the surface of water; the wings and epidermis of insects frequently exhibit it. As examples of the other sort we may instance the changeable colors of mother-of-pearl, also of certain metallic plumes of birds.

Other colors are caused by the refraction of light in passing through transparent bodies, as in the flash of the diamond or dewdrop, the tints of the rainbow, the mock sun.

All visible objects must have some color, for color is an essential property of light by which they are seen. Many colors, however, are rarely spoken of as such, because of their dull shades. We, therefore, in good faith, will confine our attention to such marked or striking colors as are usually intended by the word.

Colors may be classed, according to their uses, into incidental or non-significant colors, protective colors, directive colors, and ornamental colors.

TABLE OF COLORATION OF ANIMALS AND PLANTS.

Types of Coloration.	*Examples.*
INCIDENTAL	Color of internal tissues, pearly lining of shells; perhaps dark stripe on back of a donkey and dappled spots on a Norman horse (Wallace), and the motley colors of cattle.
PROTECTIVE	*Concealing* Gray for desert; white for snow fields; green for grassy plains; stripes of tiger for bamboo jungle; the color and form of a knot for the whip-poor-will resting on a tree
	Warning. Bright colors on uneatable or poisonous reptiles, fishes, insects, or plants, so also on stinging insects and plants, eyelike spots on insects
	Alluring Most solid colors of flowers are to attract insects for cross-fertilization; an Asiatic lizard is reported to have a mouth colored like a flower to attract insects within reach, bright colors attract passers-by to ripe fruits, to scatter their seeds
DIRECTIVE	*Recognition* Patches or lines of color, peculiar to the species, usually associated with concealing coloration, and shown often automatically, when moving or calling, white on tail of rabbit, white or black on tail, wing or head of birds, and head, rump or tail of quadrupeds, the upper side of butterflies' wings
	Indicative Many markings which serve the last-mentioned above may also serve under this The former may be seen at a distance; the latter closer by, in troops or flocks or in dens
ORNAMENTAL	Bright-colored patches of feather, hair, scales or skin, as the case may be, which are displayed conspicuously by males, particularly during the breeding season

INCIDENTAL OR NONSIGNIFICANT COLORS.

Under this head we place most of the colors of inanimate objects. Because of their insensate character they are incapable of being affected either favorably or unfavorably. Their existence is in no way dependent upon their relations to their color. The glitter of gold, the flash of the diamond, the azure tint of the sky, however appreciated by man, are perfectly useless to the objects themselves and are purely incidental to their molecular structure.

The same may be said of the color of blood, of internal tissues, and the delicate tints of shells. Such colors are of no service to the organism. Furthermore, the same is probably true of many colors upon the external surface, as the verdure of plants or the brighter colors of foliage plants, whose tints seem to follow or vary with the structure. So also with the haphazard coloring of domestic animals; the more regular markings which follow certain parts of the internal structure, as the black stripe along the back of a donkey or the dappled spots upon a Norman horse, which seem to be collections of pigment somewhat after the principles of mineral concretion. Wallace is disposed to refer to this cause much of the gaudy coloration of the males of many species of birds. The brilliant colors he thinks are simply incidental manifestations of exuberant vitality, but such cases are quite differently interpreted by others. Incidental colors may be looked upon as the primitive coloration of animals and plants, which have furnished the material from which natural selection has developed colors which are of service or use to the organism, and under this head we find the other classes of color which we have mentioned.

PROTECTIVE COLORS.

Under this we include all patterns and tints of coloration which are of service in protecting the organism and its enemies and also for enabling it to catch its prey. This class may be subdivided, therefore, into *concealing* colors, *warning* colors, and *alluring* colors The first includes all coloration which tends to hide the organism. The more common examples are those of dull gray for animals inhabiting desert regions, white for those in snowy countries, some greenish tint for those frequenting leaves or grass, transparency for water animals. Sometimes the animal has its color changed from gray to white when the snow falls; in such cases it seems that a certain sensitiveness to light resides in the hair or skin. This is seen in the ermine, the arctic hare, and ptarmigan. Sometimes the color is changed by some effect through the nervous system upon the pigment cells of the skin. This is notably true of the chameleon, and in less degree in some tree toads. Somewhat similarly, chrysalids of certain insects conform to the objects they rest upon. In other cases concealment is curiously secured by coloring of the plant or animal to resemble some inanimate object. The whip-poor-will is colored to represent a knot on the side of a tree, the tiger to resemble the light and shade in a bamboo jungle; sunbirds are colored like the flowers they frequent.

Many insects, in either larval or adult stages, by their color and form imitate so closely the leaves, twigs or thorns that they are practically invisible. The underside of the wings of many butterflies cause them to resemble dry leaves.

On the other hand, some small animals and insects which are uneatable or harmful advertise the fact by exhibiting bright colors in sharp contrast with surrounding objects. Such *warning* colors are found in the skunk, many snakes and other reptiles, bees, wasps and many other insects, sea animals, and bright-colored corals.

Some are protected by their resemblance in coloring to others which are harmful. Beetles are in some cases shaped and colored like wasps or stinging ants. Many caterpillars are furnished with eyespots and other marks to make them appear monstrous and dangerous to birds Probably the eyespots on the wings of some butterflies serve a similar purpose.

Other colors which are calculated to *allure* insects or other animals, so that they may be captured for food, may also be grouped under protective colors. An Asiatic lizard has its mouth colored brightly so as to resemble a flower, so that insects draw near it and are taken. A species of mantis in India resembles a pink flower, and so attracts insects within its reach; so also with some spiders.

Thus far we have spoken mainly of animals. Plants may also be protected by their coloration. This is not so often by the possession of hiding colors or warning colors, but more by alluring colors, although not for injury to their victims. All showy flowers are now looked upon as a device of nature to promote cross-fertilization in plants. The insects scour the fields for food; each species of flowers presents a particular color as a signal which indicates that it has food for it at hand. An insect visits a plant to gather the nectar or pollen, and dusts himself more or less with pollen, which he carries to a neighboring plant of the same species; and so from plant to plant through the

day; or, if of nocturnal habit, through the night. Myriad and wonderful indeed are the devices which nature has formed to promote this process—forms of flowers, often very complicated, and the arrangement of flowers—but in nearly all color is the main attraction. Sometimes it is odor.

"Hence we may conclude," as Darwin says, "that if insects had not been developed on the earth our plants would not have been decked with beautiful flowers, but would have produced only such poor flowers as we see on our fir, oak, nut and ash trees, on grasses, dock and nettles, which are fertilized by the wind." This idea has grown greatly in favor since its first announcement. From crocus to aster, and from violet to magnolia, the same story comes. Thus the difficulty of the poet who sang of the violet "born to blush unseen and waste its sweetness on the desert air" is satisfactorily solved.

Alluring colors are also important to edible fruits. How they shine out and notify the passer-by that they are ripe and ready to have their seeds scattered. The blush of the peach, the gold of the orange, the glitter of the blackberry, all exist mainly because of their utility to their species. This form of alluring coloration brings us by an easy stage to our next general class:

DIRECTIVE* COLORS.

This class includes all which are in any way useful to a species, by securing its recognition by its friends, or by enabling them to judge of its attitude and probable movement; hence it is easily separated into what we may call *recognition* colors and *indicative* colors. Both functions may sometimes be served by the same marks. It will be seen that recognition colors have a purpose exactly opposite to that of concealing colors, but they are often exhibited in the same animal. One of the early puzzles to evolutionists was the white tail of the rabbit, which seemed an obvious disadvantage. A little study, however, discovered its utility in enabling rabbits to find or follow one another in the twilight. So animals protected by hiding colors invariably have some conspicuous stripes or spots of striking color, usually white or black, on tail, rump or wing. They are commonly concealed when the animal is hiding or at rest, but are automatically displayed when the animal is in motion or when calling its fellows. The white or black tails of deer, the white feathers in the tail and wings of finches, the bar across the tail of the turkey, the white rump of the flicker, are all examples of this class; also the bright colors upon the upper surface of butterflies' wings. Very likely the color of crow, bluebird or scarlet tanager may come under this class, although they may possibly belong to warning colors.

Indicative colors are especially important to animals which move in flocks. They are helpful not only when moving in a mass, but also when resting at night. Similar marks are serviceable to animals which frequent dens. Under indicative colors we would class: (*a*) Conspicuous streaks or contrasts of color about the head, as in the raccoon, badger, antelope, etc.; also in the hawks, sparrows, geese, etc. (*b*) Spots and lines on the sides and legs, as in zebras, peccaries, antelope, wild asses, hunting dogs, etc. (*c*) Various spots and lines appearing only in the young as in fawns, the cubs of some Felidæ and Suidæ. These are of temporary service while they are confined to their hidingplaces. But indicative coloration is not confined to animals, though, of course,

* This term was first suggested by the writer, 1888. American Naturalist, XXII, p. 201.

it appeals to the intelligence of animals. Under this head, we judge, rightly belong most of the delicate markings upon flowers which are too small to be seen at a distance. They have been called "guide lines" and "spots," because they show the visiting insect or bird the way to the nectar. They are found especially in flowers of irregular or complicated structure. They occur in the violet, iris, lobelia, etc. They often add greatly to the beauty of the flower.

ORNAMENTAL COLORS.

We now come to a branch of our subject which may be more welcome to some who may have thought that our interpretation of nature is too utilitarian. Though we have traversed by far the most extensive portion of our field, we have not yet considered some of the most wonderful and beautiful manifestations of animal coloration, which by most naturalists are believed to bear witness to the existence of an æsthetic sense in animals. I refer to the graceful crests and brilliant plumes of many birds and other bright markings on mammals, fishes and reptiles. It is usually associated with marked differences between the sexes, and is often limited to the males, and, moreover, is most conspicuous during breeding time:

"In the spring a fuller crimson comes upon the robin's breast;
In the spring the wanton lapwing gets himself another crest,
In the spring a livelier iris sparkles on the burnished dove,
In the spring a young man's fancy lightly turns to thoughts of love."

The gemlike beauty of the humming bird, the marvelous plumes of the different paradise birds, the tails and wings of the pheasant, including the peacock, the bright-colored combs and wattles are all mainly restricted to the males. The females, though sometimes reflecting the peculiarities of the male, always present them in subdued form; so with many brilliant stripes and colored patches found on antelopes, monkeys, lizards, fishes, and in insects. Wallace tries to ascribe all these to exuberant vitality, together with the need of recognition colors upon the part of the males, and the counteracting need of protective colors for the female during incubation and the care of their young. The consensus of opinion, however, of other students of the subject is clearly in favor of Darwin's view, as first announced in his theory of sexual selection. This is simply a natural selection, acting through and perfecting an æsthetic sense of the opposite sex. Love and the love of beauty under Nature's laws have wrought this miracle of splendor.

Thus have we viewed all too hastily the broad field of color in nature, with its almost infinite range of pattern, tint and shade. We have seen how it has been an important factor in the development of living forms. Although born of apparently accidental coincidences, color has, in the beneficent hands of Nature, protected the weak and timid. By its system of natural heraldry, unconsciously produced by natural selection, it has awakened and stimulated their powers of discrimination and judgment, so that they have acquired the use of a sign language, which in turn has developed their social instincts and habits. It has aroused and cultivated an æsthetic taste, which has, by reaction, still further beautified nature and natural forms.

All these enlargements of comprehension and appreciation through the general current of life have been shared in by many, but by none so much as by man, the crown of all, the "heir of all the ages." Endowed with the mysterious power of self-consciousness, he is able to look down upon himself

and the whole labyrinth of Nature's workshop in which he finds himself playing a part. Aside from and above the uses which we have been considering, he sees higher relations and deeper significance. His divinely equipped soul sees the spiritual side of the tapestry of life and begins to comprehend the picture for which it was all woven.

> "To him who in the love of nature holds
> Communion with her visible forms she speaks
> A various languag."

These the artist learns to interpret and to express in tint and form, and the poet in word and rhythm. They become a vocabulary to impress the noblest, gentlest and sublimest thoughts and feelings. Flowers, gems and brilliant birds become letters in this wonderful alphabet.

Nor can we contemplate such a perplexity of influences and relations acting, reacting and interacting without recognizing the existence of a beneficent Intelligent Mind, as the only adequate explanation for it all. We realize that we have been permitted to enter the laboratory of the Infinite, to learn something of His methods of work and to think in our feeble measure some of His wonderful thought after him.

A New Nesting Record for the Pine Siskin.

F F CREVECOEUR

May 3 of last year I discovered the nest of a bird in a cedar tree by the house containing three or four recently hatched young. The bird appeared unfamiliar to me. It had much the looks of a sparrow, and Lincoln and Harris' sparrows had been seen about the place; but as these birds are not supposed to nest this far south, I was greatly puzzled as to the bird's identity. One of the birds was nearly always to be seen on the nest, and I used a spy-glass to get a good look at it, but I could not place it. One day I saw near by another bird, which was evidently the mate to the one on the nest, and as it flew about I noticed it had a forked tail—a character not common among sparrows. This gave me a clew on which to work. Consulting Goss's "History of the Birds of Kansas," I soon came to the conclusion that the bird must be the pine siskin. But Goss in his book says. "Winter sojourner; not uncommon. Remain until late in spring. . . . They breed from the northern United States (much farther south in the Rocky Mountains) northward throughout the British possessions." So I could not be sure as to the bird's identity. I wrote to the Bureau of Biology to send a man out, if they could, who would be able to identify the bird. Dr. E. W. Nelson, chief of the Bureau, wrote in reply that a man could not be sent out, but it would not be improbable that my bird was in reality the pine siskin, as it had been known to breed on several occasions at Omaha, Neb., and it was quite possible the bird might breed as far south as Onaga, Kan. By the time Doctor Nelson's letter reached me the young had left the nest and the birds were not seen afterward.

Last September I made a trip to Topeka, and while there I looked up the pine siskin in the Goss collection of birds in the museum there, and immediately recognized the bird to be the same as the one I had under notice; so there can be no question as to its identity.

Additions to the List of Kansas Lepidoptera.

F F Crevecoeur.

In volume 4 of the Transactions of the Kansas Academy of Science, Doctor Snow listed 503 species of Lepidoptera collected in Kansas. In volume 7 of the Transactions he listed 45 more species, and in the *Kansas University Science Bulletin,* volume 2, No. 4, for November, 1903, he listed 79 additional species. During the nearly thirty years of collecting near my home I had quite a number of species which are not contained in Doctor Snow's lists. Of these there are 176 species which are listed below. These added to the 627 species listed by Doctor Snow make a total of 803 species so far recorded from the state.

After so many years of collecting I was rather surprised last fall when I took several species of insects which I had not collected before Among these were *Triptogon modesta* and *Limenitis weidemeyrii* among the Lepidoptera, besides several others among some of the other orders. While on a visit last fall near Osage City I there collected *Terias mexicana, Cirrophanus triangulifer* and *Thyridopteryx ephemeræformis,* all species new to my collecting, but only the last new to the Kansas list From this I am convinced there is still much to be done in the way of collecting insects in the different orders which have not been listed from the state, with the possible exception of the Coleoptera, in which Mr. Warren Knaus has done much good work in collecting and recording with such tireless devotion.

LEPIDOPTERA NEW TO THE KANSAS LIST.

The first numbers refer to Dyar's list of 1902; the numbers following names refer to Smith's list of 1891.

91. *Agraulia vanillæ* Linn. A badly weather-beaten specimen was taken in the fall of the year in my early days of collecting, about 1890 The specimen, as near as I can remember, was identified by Fred Marlatt, of Manhattan.
345. *Thecla edwardsii* Saunders.
393. *Chrysophanus thœ* Bdv.
535. *Euphyes fusca* G. & R. (559.)
772. *Adelocephala Bicolor* Harr. (1378.)
794. *Ctenucha cressonana* Grt.
839a. *Haploa reversa* Stretch. (1026.)
839b. *Haploa fulvicosta* Clem. (1028.)
863. *Diacrisia latipennis* Stretch. (1094.)
905. *Ammalo tenera* Hub. (1113.)
968. *Raphia frater* Grt.
975. *Apatela dactylina* Grt. (1521.)
994. *Apatela furcifera* Gn. (1499.)
1003. *Apatela hamamelis* Gn. (1540.)
1037. *Apatela xyliniformis* Gn. (1548.)
1067. *Chytonix palliatricula* Gn.
1117. *Perigea vecors* Gn. (2093.)
1205. *Hadena semicana* Walk. (2060.)

1293. *Pyrophila glabella* Morr.
1397. *Rhynchagrotis alternata* Grt.
1540. *Feltia jaculifera* Gn.
1759. *Ufeus plicatus* Grt.
1825. *Mamestra goodellii* Grt.
1829. *Mamestra renigera* Steph.
1962. *Heliophila rubripennis* Grt. & Rob. (2264.)
1963. *Heliophila albilinea* Hub. (2266.)
2351. *Schinia tertia* Grt.
2366a. *Schinia atrites* Grt.
2389. *Dasyspoudea lucens* Morr.
2469. *Panchrysia purpurigera* Walk. (2575.)
2474. *Plusia ærea* Hub.
2556. *Anomis erosa* Hub.
2568. *Rivula propinqualis* Gn.
2605. *Eustrotia synochitis* G. & R. (2903.)
2607. *Eustrotia muscosula* Gn. (2906.)
2654. *Metoponia perflava* Harvey.
2660. *Therasia angustipennis* Grt. (2837.)
2696. *Fruva tortricina* Zell. (2858.)
2946. *Celiptera frustulum* Cn.
3036. *Philometra metonalis* Walk.
3039. *Chytolita morbidalis* Gn. (3228.)
3048. *Renia flavipunctalis* Geyer.
3067. *Bomolocha scutellaris* Grt.
3069. *Bomolocha madefactalis* Gn.
3142. *Heterocampa bilineata* Pack. (1297.)
3162. *Harpyia cinerea* Walk. (1343.)
3222. *Heteropacha rileyana* Harv.
3225. *Eudeilinea herminiata* Gn.
3232. *Dyspteris abortivaria* H.-S
3271. *Tephroclystis implicata* Walk. (3959.)
3332. *Euchaeta albovittata* Gn. (3835.)
3340. *Hydria undulata* Linn. (3854.)
3457. *Petrophora ferrugata* Clerck. (3909.)
3469. *Erastria amaturaria* Walk. (3581.)
3477. *Deptalia insularia* Gn. (3505.)
3494. *Xystrota hepaticaria* Gn. (3510.)
3562. *Chlorochlamys phyllinaria* Zell. (3469.)
3608. *Orthofidonia vestaliata* Gn. (3596.)
3614. *Mellilla inextricata* Walk. (3708.)
3623. *Deilinea variolaria* Gn.
3653. *Sciagraphia respersata* Hulst. (3618.)
3667. *Philobia enotata* Gn. (3607.)
3705. *Cymatophora subcessaria* Walk. (3670.)
3759. *Catopyrrha coloraria* Fabr. (3730.)
3759a. *Catopyrrha olenusaria* Walk. (3730a.)
3807. *Lytrosis unitaria* H.-S. (3757.)
3916. *Eugonobapta nivosaria* Gn. (3509.)

3948. *Gonodontis distycharia* Gn. (3369.)
3981. *Metanema inatomaria* Gn.
4013. *Sabulodes sulphurata* Pack. (3421.)
4016. *Sabulodes lorata* Grt. (3349.)
4097*a*. *Lithacodes laticlavia* Clem. (1200*a*.)
4111. *Lagoa pyxidifera* S. & A.
4129. *Harrisina americana* Gn.-Menn.
4264. *Glaphria sesquistrialis* Hub. (4160.)
4272. *Symphysa eripalis* Grt. (4165)
4273. *Lipocosma sicalis* Walk. (4149)
4275. *Hymenia perspectalis* Hub.
4285. *Samea ecclesialis* Gn.
4302. *Blepharomastix ranalis* Gn. (4069.)
4303. *Blepharomastix magnalis* Gn. (4151.)
4321. *Diaphania quadristigmalis* Gn. (3972.)
4349. *Loxostege obliteralis* Walk.
4354. *Loxostege similalis* Gn.
4359. *Loxostege commixtalis* Walk. (4112.)
4375. *Loxostege sesquialteralis* Zell. (4027)
4381. *Diasemia roseopennalis* Hulst. (4031.)
4400. *Perispasta cœculalis* Zell
4414. *Cindaphia bicoloralis* Gn.
4417. *Pyrausta pertextalis* Leder.
4426. *Pyrausta orphisalis* Walk.
4441. *Pyrausta futilalis* Leder.
4448. *Pyrausta phœnicealis* Hub. (4012.)
4454. *Pyrausta insequalis* Gn.
4462. *Pyrausta volupialis* Grt.
4511. *Aglossa cuprealis* Hub.
4513. *Hypsopygia costalis* Fabr. (4203.)
4518. *Herculea thymetusalis* Walk. (4209.)
4573. *Crambus laqueatellus* Clem.
4575. *Crambus agitatellus* Clem.
4582. *Crambus elegans* Clem.
4587. *Crambus ruricolellus* Zell.
4601. *Crambus mutabilis* Clem.
4607. *Crambus caliginosellus* Clem.
4608. *Crambus zeellus* Fernald.
4612. *Crambus pexella* Zell. (4541.)
4623. *Argyria lacteella* Fabr. (4480.)
4652. *Lantaphe platanella* Clem.
4700. *Mineola amplexella* Rag.
4704. *Mineola indiginella* Zell.
4781. *Elasmopalpus lignosellus* Zell.
4835. *Euzophera ochrifrontella* Zell.
4838. *Vitula edmandsii* Pack.
——. *Honora oblitella* Zell.
4890. *Plodia interpunctella* Hub.
4911. *Peoria approximella* Walk. (4451.)

4930. *Trichoptilus ochrodactylus* Fish. (4544.)
4935. *Oxyptilus tenuidactylus* Fitch.
4981. *Pterophorus monodactylus* Linn. (4577.)
5015. *Exartema permundanum* Clem.
5017. *Exartema concinnanum* Clem.
5021. *Exartema fasciatanum* Clem.
5024. *Exartema inornatanum* Clem.
5047. *Olethreutes chionosema* Zell.
5079. *Eucosma circulana* Hub. (4847.)
5083. *Eucosma ridingsana* Rob. (4852.)
5101. *Eucosma giganteana* (4872).
5104. *Eucosma fulminana* Wlsm. (4876.)
5129. *Eucosma strenuana* Walk. (4901.)
5137. *Eucosma matutina* Grt. (4907.)
5141. *Eucosma tripartitana* Zell. (4911.)
5167. *Thiodia aspidiscana* Hub. (4920.)
5202. *Thiodia ochreicostana* Wlsm. (4936)
5213. *Proteopteryx deludana* Clem.
5219. *Proteoteras æsculanum* Riley.
5269. *Enarmonia prunivora* Walsh. (5008.)
5287. *Ecdytolopha insiticiana* Zell.
5309. *Alceris hastiana* Linn. (4616.)
5339. *Cenopis groteana* Fern.
5344. *Cœlostathma discopunctana* Clem. (4717.)
5366. *Archips semiferana* Walk. (4643.)
5400. *Toitrix albicomana* Clem.
5409. *Tortrix osseana* Scop.
5421. *Eulia triferana* Walk. (4661.) Now *Eulia velutinana* Walk.
5446. *Phalonia argentilimitana* Rob. (4750.)
5453. *Phalonia œnotherana* Riley. (4758.)
5503. *Plutella maculipennis* Curtis. (5187.)
5552. *Sitotroga cerealella* Oliv. (5335.)
5564. *Telphusa glandiferella* Zell. (5382.)
5575. *Aristotella roseosuffusella* Clem. (5470.)
5578. *Aristotella rubidella* Clem. (5471.)
5604. *Recurvaria cristatella* Cham. (5346.)
5628. *Gnorimoschema serratipalpella* Cham. (5479.)
5653. *Strobisia iridipennella* Clem.
5657. *Trichotaphe serrativitella* Zell. (5480.)
5678. *Ypsolophus ligulellus* Hub. (5527.)
5711. *Anacampsis agrimoniella* Clem. (5301.)
5756. *Gelechia nigrimaculella* Busck.
5780. *Gelechia ambrosiæella* Cham.
5846. *Cryptolechia cretacea* Zell. (5226.)
5860. *Depressaria argillacea* Wlsm.
5920. *Epicallima argenticinctella* Clem. (5549.)
6099. *Heliodines bella* Cham.
6108. *Scythris eboracensis* Zell. (5748.)
6116. *Scythris trivinctella* Zell. (5756.)
6153. *Mompha circumscriptella* Zell. (5723.)

6157. *Mompha eloisella* Clem. (5727.)
6360. *Gracillaria negundella* Cham.
6362. *Gracillaria stigmatella* Fabr. (5628.)
6455. *Argyresthia andereggiella* Dupon.
6476. *Xylestia pruniramiella* Clem.
6488. *Monopis ferruginella* Hub. (5085.)
6503. *Tinea fuscipunctella* Haw.
6558. *Adela ridingsella* Clem.
6583. *Hypocolpus mortipennellus* Grt. (5050.)

ADDENDA.

4065. *Thyridopteryx ephemeræformis* Haw. This species was abundant on a box elder tree in the dooryard of E. J. Noble, near Peterton, Kan., early in September, 1920. How it got there the owner of the place did not know.

The numbers preceding the names of the species are those under which each species is listed in Barnes and McDunnough's "Check List of the Lepidoptera of Boreal America," 1917 The numbers following the names of each species are those under which it is listed in John B. Smith's "List of Lepidoptera of North America," 1891.

150. *Dione vanillæ* Linn. (9.) A badly weathered specimen of this southern butterfly was taken in the fall of the first year of my collecting—1890, I think. It was determined by Fred Marlatt of the Kansas State Agricultural College, to whom it was submitted for identification.
363. *Strymon edwardsi* Saunders. (262.)
404. *Heodes thoe* Boisduval. (306.)
641. *Megistias fusca* Grote & Robinson. (559.)
803. *Adelocephala bicolor* Harris. (1378.)
834. *Ctenucha cressonana* Grote. (939.)
905. *Ammalo tenera* Hubner. (1113.)
953. *Diacrisia latipennis* Stretch. (1094.)
1032. *Haploa colona* Hbn. (1026.)
Haploa colona form *fulvicosta* Clemens. (1028.)
1173. *Schinia tertia* Grt. (2734.)
1403. *Feltia subgothica* Haworth. (1714.)
1522. *Ufeus plicatus* Grt. (2291.)
1588. *Rhynchagrotis alternata* Grt. (1582.)
1718. *Polia goodelli* Grt. (1927.)
1750. *Polia renigera* Stephens. (1931.)
1958. *Neleucania rubripennis* G. & R. (2264.)
1959. *Neleucania albilinea* Hbn. (2266.)
2241. *Amphipyra glabella* Morrison. (2325.)
2327. *Perigea vecors* Guenee. (2093.)
2340. *Oligia semicana* Walker. (2060.)
2400. *Chytonix palliatricula* Gn. (1573.)
2451. *Acronycta hamamelis* Gn. (1540.)
2492. *Acronycta dactylina* Grt. (1521.)

2499. *Acronycta longa* Gn. (1548.)
2764. *Stiriodes perflava* Harvey. (2936.)
2894. *Lithacodia synochitis* G. & R. (2903.)
2902. *Lithacodia muscosula* Gn. (2906.)
2950. *Tarachidia tortricina* Zellner. (2858.)
2971. *Conacontia angustipennis* Grt. (2837.)
3016. *Baileya ophthalmica* Gn. (1472.)
3136. *Cœnurgia crassiuscula* Haw. (2940.)
3153. *Celiptera frustulum* Gn. (3092.)
3276. *Plusia œrea* Hbn. (2578.)
3281. *Pseudeva purpurigera* Wlk. (2575.)
3289. *Raphia frater* Grt. (1481.)
3407 *Anomis erosa* Hbn. (2559.)
3434. *Rivula propinqualis* Gn. (3250.)
3516. *Philometra metonalis* Wlk. (3217.)
3519. *Chytolita morbidalis* Gn. (3228.)
3528. *Renia flavipunctalis* Geyer. (3266.)
3563. *Bomolocha palparia* Wlk. (3279.)
3566. *Bomolocha madefactalis* Gn. (3228.)
3644. *Heterocampa bilineata* Packard. (1297)
3671. *Cerura cinerea* Wlk. (1343.)
3753. *Heteropacha rileyana* Harv. (1412.)
3756. *Eudeilinea herminiata* Gn. (3595.)
3819. *Chlorochlamys pyhllinaria* Zell. (3469.)
3848. *Xystrota hepaticaria* Gn. (3510.)
3913. *Timandra amaturaria* Wlk. (3581.)
3914. *Pleuroprucha insularia* Gn. (3505.)
3942. *Trichodesia albovittata* Gn. (3835.)
3962. *Dyspteris abortivaria* Herrich-Schæffer. (2485.)
3971. *Calocalpe undulata* Linn. (3854.)
4039. *Xanthorhœ ferrugata* Clerk. (3909.)
4293. *Bapta vestaliata* Gn. (3596.)
4360. *Phasiane respersata* Hulst. (3618.)
4276. *Eupithecia anticaria* Wlk. (3959.)
4293. *Bapta vestaliata* Gn. (3596.)
4299. *Mellilla inextricata* Wlk. (3708.)
4307. *Cabera variolaria* Gn. (3590.)
4331. *Philobia œmulataria* Wlk. (3607.)
4360. *Phasiane respersata* Hulst. (3618.)
4408. *Itame subcessaria* Wlk. (3670.)
4460. *Catopyrrha coloraria* Fabricius. (3730.)
Catopyrrha olenusaria Wlk. (3730*a*.)
4496. *Lytrosis unitaria* H.-S. (3757.)
4661. *Eugonobapta nivosaria* Gn. (3509.)
4721. *Metanema inatomaria* Gn. (3355.)
4757. *Apica distycharia* Gn. (3369.)
4763. *Sabulodes arcasaria* Wlk. (3421.)
4769. *Sabulodes lorata* Grt. (3349.)

4798. *Thyridopteryx ephemeræformis* Haw. (1220.) Cases containing larvæ of this destructive moth were abundant on a box elder tree near the home of E. J. Noble, Osage city, Kan., early in September, 1920. Instruction was given Mr. Noble how to rid his premises of the pest.
4842. *Lithacodes fasciola* H.-S. (1200*a*.)
4863. *Lagoa pyxidifera* Abbott & Smith. (1172.)
4881. *Harrisina americana* Guerin-Meneville. (927.)
4900. *Glaphyria sesquistrialis* Hbn. (4160.)
4912. *Egesta eripalis* Grt. (4165.)
4913. *Lipocosma sicalis* Wlk. (4149.)
4919. *Hymenia perspectalis* Hbn. (3982.)
4931. *Samea ecclesialis* Gn. (4185.)
4954. *Blepharomastix magnalis* Gn. (4151.)
4955. *Blepharomastix ranalis* Gn. (4069.)
4978. *Diaphania quadristigmalis* Gn. (3972.)
5020. *Loxostege obliteralis* Wlk. (4104.)
5025. *Loxostege similalis* Gn. (4092.)
5032. *Loxostege commixtalis* Wlk. (4112.)
5046. *Loxostege sesquialteralis* Zell. (4027.)
5053. *Diasemia roseopennalis* Hulst. (4031.)
5087. *Perispasta cæculalis* Zell. (4199.)
5103. *Cindaphia bicoloralis* Gn. (3990.)
5111. *Pyrausta pertextalis* Lederer. (4071.)
5134. *Pyrausta futilalis* Led. (4053.)
5145. *Pyrausta phœnicealis* Hbn. (4012.)
5152. *Pyrausta subsequalis* Gn. (4005.)
5153. *Pyrausta orphisalis* Wlk. (4004.)
5163. *Pyrausta volupialis* Grt. (4009.)
5249. *Aglossa cuprealis* Hbn. (4212.)
5259. *Hypsopygia costalis* Fabr. (4203.)
5264. *Herculia thymetusalis* Wlk. (4209.)
5355. *Crambus agitatellus* Clem. (4507.)
5358. *Crambus laqueatellus* Clem. (4505.)
5366. *Crambus elegans* Clem. (4526.)
5371. *Crambus ruricolellus* Zell. (4523.)
5384. *Crambus mutabilis* Clem. (4537.)
5397. *Crambus caliginosellus* Clem. (4533.)
5398. *Crambus zeellus* Fernald. (4534.)
5403. *Thaumatopsis pexellus* Zell. (4541.)
5422. *Argyria lacteella* Fabr. (4480.)
5489. *Tetralopha militella* Zell. (4226.)
5549. *Mineola amplexella* Ragonot. (4275.)
5553. *Mineola indiginella* Zell. (4278.)
5657. *Elasmopalpus lignosellus* Zell. (4343.)
5721. *Euzophera ochrifrontella* Zell. (4380.)
5726. *Vitula edmandsi* Pack. (4383.)
5807. *Plodia interpunctella* Hbn. (4426.)
5835. *Peoria approximella* Wlk. (4451.)

5854. *Trichoptilus congrualis* Wlk. (4544.)
5860. *Oxyptilus tenuidactylus* Fitch. (4597.)
5942. *Pterophorus monodactylus* Linn. (4577.)
6008. *Mompha eloisella* Clem. (5727.)
6009. *Mompha circumscriptella* Zell. (5723.)
6038. *Sitotroga cerealella* Olivier. (5335.)
6041. *Aristotelia roseosuffusella* Clem. (5470.)
6044. *Aristotelia rubidella* Chambers. (5471.)
6084. *Telphusa glandiferella* Zell. (5382.)
6106. *Gnorimoschema serratipalpella* Cham. (5479.)
6147. *Recurvaria cristatella* Cham. (5346.)
6199. *Anacampsis agrimoniella* Clem. (5301.)
6266. *Gelechia nigrimaculella* Busck. (5418.)
6306. *Gelechia ambrosiæella* Cham. (5308.)
6357. *Trichotaphe serraticitella* Zell. (5480.)
6380. *Dichomeris liguella* Hbn. (5527.)
6399. *Strobisia iridipennella* Clem. (5583.)
6417. *Cryptolechia cretacea* Zell. (5226.)
6459. *Agnopteryx argillacea* Walsingham. (5252.)
6490. *Epicallima argenticinctella* Clem. (5549.)
6798. *Exartema permundanum* Clem. (4788.)
6800. *Exartema concinnanum* Clem. (4790.)
6804. *Exartema fasciatanum* Clem. (4794.)
6807. *Exartema inornatum* Clem. (4797.)
6847. *Argyroploce chionosema* Zell. (4821.)
6894. *Eucosma ridingsana* Robinson. (4852.)
6901. *Eucosma circulana* Hbn. (4847.)
6937. *Eucosma fulminana* Wlshm. (4876.)
6962. *Eucosma matutina* Grt. (4907.)
6981. *Eucosma strenuana* Wlk. (4901.)
7021. *Eucosma giganteana* Riley. (4872.)
7025. *Eucosma tripartitana* Zell. (4911.)
7055. *Eucosma aspidiscana* Hbn. (4920.)
7057. *Eucosma ochreicostana* Wlshm. (4936.)
7116. *Proteopteryx deludana* Clem. (4958.)
7130. *Proteoteras æsculana* Riley. (4962.)
7208. *Laspeyresia prunivora* Wlshm. (5008.)
7253. *Ecdytolopha insiticiana* Zell. (5022.)
7281. *Coelostathma discopunctana* Clem. (4717.)
7290. *Sparganothis groteana* Fern. (4708.)
7354. *Cacœcia semiferana* Wlk. (4643.)
7390. *Eulia velutiana* Wlk. (4661.)
7401. *Cnephasia osseana* Scopoli. (4667.)
7409. *Argyrotoxa albicomana* Clem. (4680.)
7439. *Peronea hastiana* Linn. (4616.)
7467. *Phalonia argentilimitana* Rob. (4750.)
7487. *Phalonia œnotherana* Riley. (4758.)
7562. *Heliodines bella* Cham. (5762.)
7683. *Plutella maculipennis* Curtis. (5187.)

7695. *Argyresthia oreasella* Clem. (5161.)
8040. *Gracillaria negundella* Cham. (5624.)
8061. *Gracillaria purpuriella* Cham. (5628.)
8080. *Scythris eboracensis* Zell. (5748.)
8088. *Scythris trivinctella* Zell. (5756.)
8169. *Acrolophus mortipennellus* Grt. (5050.)
8234. *Xylestia pruniramiella* Clem. (5070.)
8242. *Monopis crocicapitella* (5085.)
8249. *Tinea fuscipunctella* Haw. (5089.)
8449. *Adela ridingsella* Clem. (5145.)

Additions to the List of Kansas Hymenoptera.

F. F. Crevecoeur.

In volume 16 of the Transactions of the Kansas Academy of Science is to be found a list of Hymenoptera collected in Kansas, compiled by Mr. J. C. Bridwell, of Baldwin, Kan. The list, which is to be found on page 203 of said volume and which contains 750 species, subspecies and varieties, Mr. Bridwell admits lacks much of being complete, as he had not had the lists of Kansas Hymenoptera in the collections of the State University, in the National Museum and in the collections of the American Entomological Society.

In my collection of insects, now in the museum of Ottawa University, are many species not contained in Mr. Bridwell's list, a list of which I herewith append. In this list are 269 species and subspecies, of which 70 have not been specifically identified, and of which some may have been included in Mr. Bridwell's list.

Abia kennicottii Nort.
Acrolyta aletiæ Ashm.
Adexionia sp.
Ænigmostoma sp.
Agenia bombycina Cr.
Agenia accepta Cr.
Agathis tibiator Prov.
Alyson guidardi Prov.
Alyson sp.
Amblyteles stadaconensis Cr.
Ammophila arvensis St. Farg.
Ammophila vulgaris.
Amolyaspis occidentalis Ashm.
Anastatus mirabilis Walsh.
Andrena sp.
Anomalon unicolor Prov.
Anomalon sp.
Antistrophus silphius Gill.
Apanteles parorgyiæ Ashm.
Aphænogaster tenesseens Mayr.
Arachnophaga sp.
Ascogaster sp.
Augochlora sp.
Bembex spinolæ Riley.
Blacus longicaudus Prov.
Bracon brachyurus Ashm.
Bracon dorsator Say.
Bracon euurus Ashm.
Bracon negator Say.
Bracon negosiocutris Ashm.
Bracon nigropectus Prov.
Bracon rugiceps.
Bracon trifolii Ashm.
Cacus œcanthi Riley.
Cœnophanes aciculatus Ashm.
Cœnophanes prodoxi Riley.
Cœnophanes sp.
Camponotus castaneus Latr.
Camponotus marginatus Latr.
Camponotus sp.
Campoplex semirufus Prov.
Campoplex viticollis Nort.

Campoplex sp.
Cardiochilus californicus Ashm.
Cardiochilus dimidiatus Ashm.
Catolaccus tylodermatis Ashm.
Catolaccus sp.
Ceraphron pallidiventris Ashm.
Ceratosoma apicalis Cr.
Cerceris dentifrons.
Cerceris nigrescens Smith
Cerceris sp.
Ceropales sp
Ceroxys obscuricornis Loew.
Chalcaspis sp.
Chalcis ovata.
Chloneurus sp.
Chrysis cobaltina Aaron
Chrysis cupricollis Cr.
Cœnocœlius rubriceps Prov
Comys scutellata.
Coriphoctonus sp.
Cosmocoma œcanthi Ashm.
Crabro sp.
Cremastogaster lineolata Say.
Cremastus hartii Ashm.
Cremastus mellipes Prov.
Cremastus retiniæ Cr.
Cremnops exaratus Cr.
Cryptus atrocollaris Walsh.
Cryptus nuncius Say.
Cryptus sp.
Dacnusa crassitella Prov
Dacnusa sp.
Dialeogaster melligaster Prov.
Dicœlotus sp.
Dolerus sp.
Dorycetes sp.
Dorymyrmex sp.
Eciton schmittii.
Entedon bigloviæ.
Epeolus concavus.
Epeolus mercatus Fabr.
Epimecis wiltii Cr.
Ericrocis fumipennis Say.
Euceros medialis Cr.
Eucoilidea canadensis Ashm.
Eucyrtus sp.
Euderus tibialis Ashm.
Eupelmus dryorhizoxeni Ashm.
Eupelmus juglandis.
Eupelmus sp.
Euplectrus frontalis.
Eutrichosoma mirabilis Ashm.
Evania sp.
Exochus pleuralis Cr. sp. nov.
Formica nitidiventris.
Formica subsericea.
Formica sp.
Glypta pulchripes.
Glytodoryctes sp.
Gonatocerus sp.
Gonatopus sp
Gorytes phaleratus
Habropelta armatus Say.
Halictus albitarsus Cr.
Halictus palustris Robt.
Hemiteles mesochori Ashm
Hemiteles sp
Heteropelma sp.
Hoplisus morulus Say
Hormeus melleus Ashm
Hylotoma abdominalis.
Ichnœops xanthaspis Ashm
Ichneumon galenus
Ichneumon finitimus Cr.
Ichneumon grotei Cr
Ichneumon pedalis Cr
Ichneumon ventralis Cr.
Ichneumon sp
Joppidium ruficeps Ashm.
Labidus harrisii Hald.
Lampronota exigua Cr.
Lampronota frigida Cr.
Lampronota sp
Larra americana Cr.
Larra argentata Say.
Larra punctifrons Fox.
Larra quebecensis Prov.
Larra torcata Say.
Larra vinulenta Cr.
Larra sp.
Lasius clavagers.
Lasius interjectus Mayr.
Lasius latipes.
Leptothorax curvispinosus Mayr.
Leptothorax schaumii Rogers.
Leptothorax sp.
Limneria annullipes Cr.
Limneria eurycreonis Ashm.

Limneria oligiæ.
Macrocentrus delicatus Cr.
Macrophya incerta.
Macrophya sp.
Macrotelia floridana Ashm.
Macroxyla sp.
Megachile inimica.
Megachile pugnata.
Megastigmus sp.
Meniscus sp.
Mesochorus uniformis.
Mesoleptus sp.
Mesostenus thoracicus Cr.
Mesostenus sp.
Metapon californicum Ashm.
Microdus bicolor Cr.
Microdus laticinctus Cr.
Microdus linatus Cr.
Mixogaster breviventris Kahl.
Mutilla fenestrata St. Farg.
Myrmica sulcinodis Nyl.
Myrmica sp.
Myzine costata Say.
Myzine namea Fabr
Nepiera albomaculata Ashm.
Nomada modesta Cr.
Nototrachys texanus Cr.
Notozus sp.
Nysson plagiatus.
Odontomerus mellipes Say.
Odynerus colon Cr.
Odynerus firmus Cr.
Odynerus pertinax Sauss.
Odynerus rustrinus.
Odynerus sp.
Ophialtes sp.
Ophion macrurum Linn.
Opius anthomyiæ Ashm.
Orasema coloradensis.
Orthocentrus canadensis Prov.
Osmia subfasciata Cr.
Oxybelus packardi Robt.
Pachynematus corniger Nort.
Palloptera superba Loew.
Perilampus fulvicornis.
Pezomachus sp.
Phaogenes ater Cr.
Pharsalis texana Cr.
Pheidole sp.
Phobetis sp.
Pimpla inquisitor Say.
Pimpla notanda.
Platygaster herrickii Pack.
Platylobus lineolatus Prov.
Polistes pallipes St. Farg.
Polynotus sp.
Pompilus americanus Beauv.
Pompilus cylindricus Cr.
Pompilus marginatus Say.
Pompilus navus Cr.
Ponera contractor Latr.
Ponera pennsylvanica.
Porizon delicatus Cr.
Porizon facialis.
Porizon macer Cr.
Porizon sp
Prenolepis imparis Say.
Prenolepis nietus Mayr.
Prenolepis parcula Mayr
Pristomeridea fuscipennis Ashm
Proctotrypes terminalis.
Prosopus pygmæa Cr
Protapanteles aldrichii Ashm.
Psen sp.
Psilodora impatiens.
Pteronus mendicus Nort.
Ptinus niger.
Rimphalea sp.
Rhinopsis canaliculata Say.
Rhogas sp.
Salius aliensus Smith.
Salius germanus Cr.
Schizocera brunniventris Cr.
Schizocera privatus Nort.
Selandria sp.
Sigalphus thoracicus Say.
Smicra debilis Say.
Smicra mariæ Riley.
Smicra torvina.
Solenopsis debilis.
Solenopsis sp.
Spathius trifasciatus Riley.
Sphecodes arvensis Patt.
Sphecodes sp.
Spilochalcis debilis Say.
Spilochalcis sp.
Stelis sp.
Stigmus fraternus Say.

Strongylogaster epicera Say.
Syntœtus sp.
Syntomaspis sp.
Tachysphex pepticus Say.
Tachysphex terminata Smith.
Tachysphex sp.
Tapinoma sp.
Temelucha cookii Weed.
Tenthredo cinctituœa.
Tetrastichus sp.
Thersilochus conotracheli Riley.
Thyreodon sp.
Thyreopus sp.
Tiphia tarda.
Torymus sp.
Toxoneura abdominalis Cr.
Triclistus pygmœus Cr.
Tritoxa incurva Loew.
Trogus atrocoeruleus Cr.
Trogus rileyi Cr.
Urogaster hartii.
Urogaster pallidistigma Ashm.
Urosigalphus neomexicanus Ashm.
Vipio croceus Cr.
Vipio sp.
Xanacis sp.
Xenoglossa pruinosa Say.
Xylomyia pallipes Loew.
Xylonomus cincticornis Cr.
Xylota chalybea Wied.
Zelotypa texana Ashm.

Nature's Use of Disinfectants and Antiseptics.

L. E. Sayre.

Disinfectants are used for the prevention of germ-activated waste.

They are destroyers of the bodies causing infectious diseases of animals, plants and foods.

They are preventives of the growth and multiplication of noxious germs.

They are destroyers of the microörganisms of disease already active in decomposition of organic matter.

These are essays towards a definition, but not a complete definition in the lot. One needs a definition applicable to each form or condition of perishable matter. The universal, all-potent omniapplicable disinfectant has not been devised or discovered.

If there are microbodies that can resist moderate boilings and prolonged intense freezings without destruction; that can withstand varied and various approved germicides, but which will succumb unresistingly to some one body discovered by patient research and innumerable experiments, the particular bodies selected and adapted to individual cases as disinfectants and germicides are patently very numerous. Dr. A. C. Walters has shown that there is a specificity in disinfectants, and so the universal, easily applied germ-killing body is yet to be devised; the public who asks for such a preparation will have to go unsatisfied and remain content with merely approximate remedies.

For a long time carbolic acid (phenol) was regarded as being almost omnipotent, and efforts for improvement were in the line of searching for a body superior and more efficacious. When a chemical body was found that would slay its greater number of thousands it was welcomed exultantly. The mere counting of the dead was the test.

Yet again there are disinfectants which if compared with phenol efficiency would be found inert and worthless if thus superficially estimated, but on some given virulent organism they may be actively germicidal where the phenol itself is inert. And the reverse; a disinfectant which may compare favorably

with phenol, in some respects, is found wanting; when placed in general use its utility is almost nil.

Specificity, therefore, is the most important factor in estimating the value of a disinfectant.

The original method of ascertaining the value of a disinfectant—that utilized by the hygienic laboratory—which did not carry its examination beyond its effect on a single or maybe a few microörganisms, is, therefore, shown to be an insufficient and faulty way of evaluation. Still, important and respected national councils and states have sanctioned the hygienic-laboratory method, and many there are who will even now rely on its approvals, because they have not learned of the then undiscovered fallacies of the decisions arrived at.

The personal factor affects the determining manipulations of an observer. No two men will so handle the test and the material tested equally efficiently. So hard and fast lines cannot be drawn in worth-while comparisons; only relative judgments are possible.

Freedom of thought and action on the part of investigators must be less trammeled than it is. The dicta that "this is so" and "that is not so," when applied to general health, welfare or commerce or manufactures, must be applied liberally or much injury will result in restraining progress. We plead for more freedom and less of the "hard and fast" restrictions, with, however, the reservation that all investigations should be made by the undeniably competent, the absolutely honest, the actively constructive, and perhaps the financially uninterested. There is no such thing as finality in research; there is always more beyond. The imposing of the letter of the law is frequently a branding that hurts and does not always protect. Dogma, for instance, has no place in a can of disinfectant.

Again, a false sense of danger is given vent to by the restriction to unnecessarily small amounts of preservatives permissible in canned goods, for instance. Nature may normally utilize more of the same body or a variant of the article unsuspectedly, and free of such, nature-guarded food is healthful and even craved. The hobbyist has occupied the saddle too long and too completely. When it has become patent that unnecessary restrictions have been made, a manly modification should be instituted, even before the people sense the need of relief. A bureau of administration must also be a bureau of improvement. Laws should be interpreted by regulations. Wise regulations, changed to make them wiser when necessary, would strengthen any basic law which intentionally leaves regulations to official administrators.

Very efficient disinfectants are frequently of such a poisonous character that they cannot be used in connection with foods and beverages. The toxically inert but germicidally potent remedy is often the desideratum. We can treat a cesspool, and care not how noxious the disinfecting agent is to human life; but if we wish to combat some of the germs existent in the human economy, which may infest the cesspool later, then the most good and service, and the least or no harm, is the desired quality.

In times of epidemics special measures for special uses have to be evolved. Infection must be resisted at every avenue of approach. Influenza prevailed for many winters and lingered and survived persistently in spite of all methods for attempting control. It had been conjectured and found that the necessary soda fountain was a dangerous disseminator of the disease. Even with scru-

pulous care and attention, the infecting organism would survive plain washing and rinsing of glasses and dishes. The danger was as present in the clean as in the careless store. The drinks themselves fed the microörganisms. The persistent tacky glutinosity of syrups and fruits completely sealed up morbidity, so that perfunctory cleansing availed not. The Board of Health of Kansas, through its secretary, Doctor Crumbine, requested, and requested vigorously, that something be done to protect the public and inexpensively assist the soda dispenser. Boiling water and steam disinfection would involve a greater expenditure for cleaning a glass than the profit on the consumed drink afforded. Small stores would have to quit business if compelled to use that method. In response and in connection with P. A. Patty, the writer plunged into the sea of trouble. The more or less uninjurious disinfectants were called to mind; many were dismissed at once on account of objectionable odor or taste The substance must be hard-working, rapid in action, and easily banished from the glassware. Sterility complete and unassailable must be secured in almost a flourish of the hand The remembrance of the cheap but efficient Labarraque solution of hypochlorite clung persistently to our minds. Was there no way of making it the solution in quest?

Then came the tests. Laboratory work was planned and carried out Three microörganisms were selected for the experiments—a culture of a micrococcus concerned in the genesis of boils and abscesses, a culture of the typhoid bacillus, and a culture of the streptococcus causing sore throat and skin eruptions. The last-mentioned is hard to kill. Every precaution was used to secure perfect tests. The smallest detail was observed. The speed used was purposely made the same as it would be in actually serving and selling glasses of soda water, and the cleansing afterward was performed before any drying process had taken place. Nineteen solutions were made and used. All contained available chlorine. The amount of free chlorine was not the only factor that determined efficiency. The solutions containing the greater amounts of free chlorine were no more efficient than those containing half or three-quarters less. The power depends also on the degree of alkalinity of the solution. Solution No. 18, that in our test service was the nearest to neutrality, but still alkaline, with only 0.05 per cent of available chlorine in it, was the best. Hot water is not batericidal in the time period practical. Addition of sodium salicylate added no power, although germicidal in itself. Solutions containing mercuric chloride are highly satisfactory as germicides, but impractical on account of its highly poisonous character. The nearly neutral bath containing one-twentieth of one per cent of chlorine killed all three of the microörganisms whether the bath was fresh or twenty-four hours old. Dip a recently water-rinsed glass into the bath, allowing all parts to come in contact with the solution, and sterilization is complete. A rinse in plain water and rapid drying finishes the process.

Few people can conceive how many natural disinfectants—antiseptics really they had better be called when used on living tissues—Mother Nature utilizes, and for the same purposes. Years ago the writer took part in a discussion or controversy with other chemists, among them an esteemed coworker, R. G. Eccles, M.D., of Brooklyn, N. Y., in which the claim was advanced that nature in her normal processes formed antiseptic bodies as protective agents and for the insuring of reproduction and perpetuation.

Quite recently, while investigating and estimating commercial disinfectants

and sterilizers, the ideas formulated in the years before were vividly recalled. That time has strengthened the opinions then expressed was proven on my writing to Doctor Eccles to find if he also felt as conclusively on the matter as he had in previous days. Our combined views are nearly a perfect consensus, which I may present crudely.

There is no tissue, animal or vegetable, that does not contain to some degree the basic radicals that are the chemical nucleus of our chief organic antiseptics. Their abundance is greatest where destructive danger is greatest. In the proteins are familiar bodies containing the benzene or some derivative nucleus from which we get creosote, phenol, salicylic acid and benzoic acid. We carelessly class our synthetic antiseptics as being coal-tar products. Of course coal tar is of vegetable origin and the proteins of the vegetables supplied the aromatic radicals now present in that coal tar. Plants produce their alkaloids and glucosides from these primary compounds They are found richest in parts subject to destructive infection. Among them are amygdalin, gaultherin, salicin and tannin, and they all give every indication of giving service protectively In many seeds, like plum, peach and apple, amygdalin is coupled with emulsin Injury to these seeds does not affect the glucosides until dampness favors fungoid or bacterial destructive growths; then the emulsin becomes active and releases benzaldehyde, which soon oxidizes to benzoic acid. Small external damage receives little of the antiseptic; larger wounds a larger amount of the acid In wintergreen and birch the protective glucoside is gaultherin, which when reacted on by gaultherase is converted into the antiseptic methyl salicylate. To follow up further would be tiresome. Suffice it to say that in all instances of the occurrence of glucosides and enzymes, the benzene ring plays its important part—the source that bestows antiseptic qualities.

We are now treating of present growths and their protective accompanying bodies; but if we apply the same principle to the past we reach the conclusion that if there had not been natural disinfectants we should not now have coal to burn. The only part of the vegetable material which made coal that is preserved to us is that part which was protected by the antiseptics from fungoid and other decay Changed by heat and pressure and some chemical action, the portion that remains for our use and comfort was preserved and concentrated by the parts of the trees and plants that afforded the antiseptics. In the laboratory to-day, from coal we reclaim these same nuclei and put them to further and similar uses.

To our senses the odors of plants residing in their essential oils mainly are very apparent, and it is these aromatic principles that are the tissue preservers and the securers of reproductive processes. Some are simple at first, but become more complex and potent as they oxidize into new bodies, often losing their original characteristic odor and becoming nearly odorless but more efficient.

The practical use for antiseptics in food supplies is well known and appreciated. The extremists, by baseless denunciations, have made their use seem almost criminal. Interested propaganda by some manufacturers of some less perishable articles, widely advertised, have contributed to the scare, which ought never to have arisen. The practice of the housewife of adding certain simple bodies to "make things keep" has never hurt one, and has for genera-

tions afforded good summer food in cheerless winter days. It has long been known that cooked fruits and vegetables, cooked meat and fish, when exposed to warmth and nonsterile air decompose more quickly than the same food will when perfectly fresh and under the same exposure. Fresh unheated foods resist infection longer because of the self-contained aromatic radicals easily released by cell enzymes to preserve the food. Heat-sterilized foods are ideal for the propagation of putrid growths. That is why the manufacturer instructs one to take contents from the can, and if any portion is unused to keep it refrigerated. The heat used in canning destroys nature's protecting agents. Why should not the preservatives be restored to a reasonable extent before sealing after sterilization is complete? The extremists have at times given people to understand that it was possible that salt and other innocent substances which have been used domestically since meats were first preserved would be forbidden to be used by packers. To be consistent the hobbyists should prevent the smoking of hams, bacon, fish, sausage and the like, because of the many empyreumatic products generated and absorbed—creosote, acetic acid and unknown chemical combinations that have given us the harmless and dainty foods for generations. Doctor Eccles says that, strength for strength, in antiseptic power, benzoic and salicylic acids are very much less harmful than salt or vinegar, but our food dictators would hold up their hands in horror if these were put into use.

Perhaps it will now be seen why we fear that progress will be hindered, commerce unreasonably hampered and restricted by unwise theorists who would cling to their shibboleth of law though the nation would starve. If nature's processes are in themselves largely self-preserving and of proven innocence, why cannot there be a greater leeway afforded to manufacturers, who would have to disclose their formulas, and if not generally approved offer themselves up to destructive and ruining criticism.

The burden of this rather excursive consideration of antiseptics may be given briefly: There is no intention of advocating unnecessary and indiscriminate use of antiseptics in the preservation of foods; but also the point is emphasized that if we legally and commercially discourage and make unpopular the study of antiseptics for the purpose mentioned we are absolutely hindering progress. In this day and age, when the transportation of food products immense distances is of vital importance, we should rather offer rewards and encouragement for research of this character than to practically condemn such work by greeting it with chilly indifference and faint praise.

Botanical Notes for 1920.

FRANK U. G. AGRELIUS.

In keeping with our practice for several years, we wish to offer the following items for the year 1920:

UNUSUAL SEASONAL ACTIVITIES OF CERTAIN PLANTS.

Tripsacum dactyloides L. November 18, found a frozen specimen in bloom east of Haskell School, Lawrence. A freeze of about that date had evidently caught it.

Tradescantia sp. September 18, blooming east of Lebo, Kan. (Student.)

Asparagus officinalis L. September 18, new shoots; September 19, new shoots and blooming; September 26, blooming.

Canna sp. October 30, bulb had new roots; October 29, heavy frost.

Oxybaphus linearis (Pursh.) Robinson (?). October 6, blooming.
Aquilegia canadensis L. August 9, blooming.
Delphinium ajacis L. October 19, old plants and second growth from this year's seed, blooming; October 25 and 26, blooming.
Lepidium sp. August 24, Old East Lake, blooming
Capsella bursa-pastoris Moench. October 26; December 21; January 25, 1921; January 29, 1921
Raphanus sativus L. (White icicle) August 30, ate second crop radishes, self-sown from this year's seed
Radicula sinuata (Nutt) Greene (?). August 24.
Spiræa trilobata L. (*S. van Houttei*). June 24; July 17, 21; August 4; August 9, buds and flowers; August 25 and September 13 and 19, buds and flowers; September 26, buds; September 26, blooming; October 26, blooming.
Spiræa japonica L. (*S. callosa-alba*). October 26, new flowers and buds; October 30 and November 6, new flowers and buds
Pyrus malus L (Jonathan). June 8, blooming and putting out second bunch of apples.
Pyrus prunifolia Willd (?) (Florence crab.) May 27, blooming and putting out second bunch of blossoms.
Pyrus japonica Thunb. May 27, blooming second time this season
Trifolium repens L. October 26
Melilotus officinalis (L.) Lam August 29, 31; September 1; October 6, 19, 26.
Melilotus alba Desf. August 24, 31; October 6.
Phaseolus vulgaris L October 25, second crop of self-sown beans in several stages, including flowers and green fruits
Linum rigidum Pursh (?) September 1
Oxalis violacea L August 29; September 1, 13
Oxalis stricta L September 1, October 25
Pelargonium zonale Willd October 6, 19, 26, doing well at home out of doors.
Acer saccharinum L. January 30, 1921, pistillate flowers in bloom in Maplewood cemetery; February 16, 1921, both kinds of flowers out in abundance on some trees.
Vitis labrusca L (Concord) July 17 and 21, buds; August 4, blooming, August 25, ripe, green and buds on, October 24, second crop of grapes (one bunch) fairly ripe.
Althæa rosea Cav October 30
Tamarix gallica L September 29
Viola pedatifida G Don (?) September 18, east of Lebo Reported by a student.
Œnothera speciosa Nutt September 1.
Asclepiodora viridis (Walt) Gray. August 31.
Mint (gen. and sp. ?). October 30.
Solanum nigrum L. October 30
Viburnum opulus sterilis. July 17; August 4; August 25, new flower ball; August 30; September 5, 26; October 6
Erigeron ramosus (Walt) B S. P August 31; October 6
Lepachys columnaris (Sims) T & G September 19, 28.
Achillea millefolium L September 28.
Taraxacum officinalis Weber. Have bloomed quite strongly at times, but the winter as a whole has been rather unfavorable for this flower November 6; December 12.

I am indebted to Master Homer Stephens for the data on *Pyrus*.

When only the date is given it is understood that the flower or plant is blooming.

Polycotyledony of *Lycopersicum esculentum* Mill., and *Ricinus communis* L.

We secured two plants showing tricotyledony from "Earliest of All" seed of the sowing of the spring of 1920. These were planted as far from our regular tomato patch as we could plant them. They were in a potato patch and about seventy-five feet from each other. Several rows of sweet corn separated them from the other patch. Our endeavor was to provide somewhat for self-pollination. We secured some seed from these.

We also secured two plants from seeds of tricots of the 1919 crop of our own growing. We have seed from these plants also.

So far we cannot see that we have gained anything in the way of an increased ratio of tricots in the tomatoes. However, the plants have not been as well selfed as this year. We expect to continue this experiment with the tomato.

We note the following facts concerning the work with the castor bean. We planted 265 seeds left over from a tricot of 1918. One of these was a tricot. Out of 62 seeds from the 1919 crop, which were second-generation tricots, there were three tricots. The respective ratios are 264-1 and a little better than 20-1 (59-3). This shows a considerable gain. This year for the first time we have destroyed all other plants of castor beans on the place, and hence can expect a fair certainty of self-pollination, at least as to blood. There were no plants of this kind near our place, so far as we could ascertain. We await with interest the outcome of the coming year's test. We have an abundance of seed from this year's plants for use.

An interesting fact observed on some of the plants this year was that the 120-degree angle between the three cotyledons was continued for at least two nodes up the stem. This would indicate that the polycotyledony was certainly in the blood of the plant, so to speak, and points to better results for the future.

Hermaphroditism in the Austrian Pine.

On May 16, 1920, we observed a strobile or cone of an Austrian pine in Maplewood cemetery, the upper third of which is pistillate and the rest staminate. We do not know how common this may be, but we have no recollection of having observed such a phenomenon before. We have the specimen preserved in formaldehyde.

Archæology of the Tuba-Kayenta Region.

(Continued from 1919)

Albert B Reagan

The archæological work in the field in 1920 covered a larger area than in 1919. This work verified former conclusions.

1. The Navajo is a product of absorption of other tribes, the nucleus being an Athapascan stock, evidently of the Apache branch of that family. Moreover, the Navajo stock, as we know it, is in the same region to-day that it grew up in, so to speak. In other words, it has never occupied any other region, though the Apache stock from which its nucleus sprang undoubtedly did, probably coming from the north.

2. The Utes, Piutes, and probably the Shoshonean Indians, have undoubtedly played an important rôle in this region in both remote and recent time, the present Hopis being of Shoshonean stock.

3. The intensive farming and use of water for irrigation and the reservoiring of every side mountain canyon for village use and for irrigation caused the master streams to be filled up and the valleys to be aggraded, a process which continued even to our own time. Professor Gregory[1] says a lack of rainfall

1. See Gregory, Herbert E.; Geology of the Navajo country: U. S. Geol. Prof. Paper 93, pp. 130-132.

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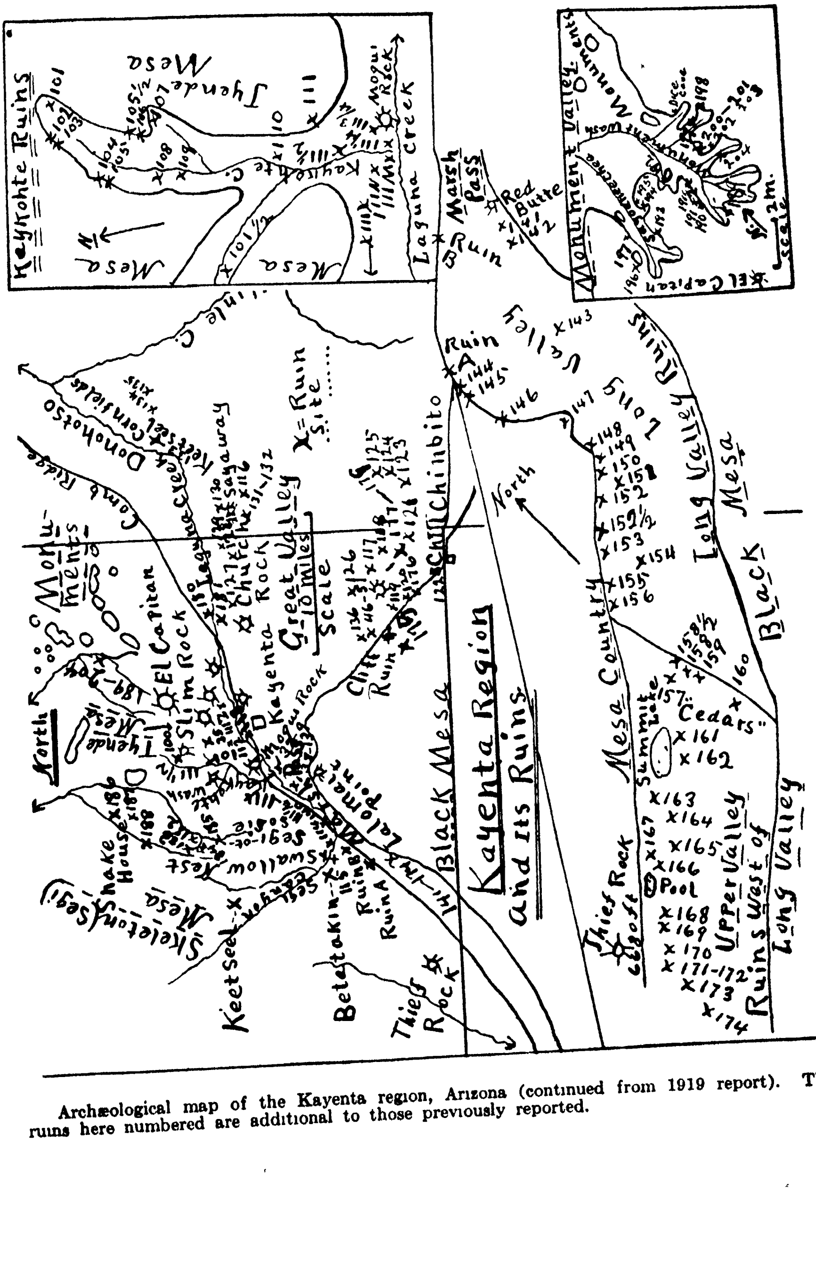
PLATE I.



Archæological map of the Kayenta region, Arizona (continued from 1919 report). The ruins here numbered are additional to those previously reported.

to a certain limit would cause the valleys to be aggraded. If, on the other hand, man used the water to that same limit, the aggrading result would be the same. And the evidence that the cliff dwellers did so is unquestionable. Every side wash canyon and flat had its village or villages, its dams, ditches and reservoirs, as is readily seen by carefully examining the region. The aggrading of the valley floors and the often laking of same was evidently directly due to man's work. This is attested by the fact (1) that the flora and fauna is now the same as when the cliff dwellers lived here, with the exception of what the white man has exterminated since his coming; (2) and that in the sections that have little rainfall now, such as the flats about and to the north of El Capitan, but few villages in the open or in the canyons are found, and these are often small, whether open or cliff ruins, indicating that they were merely hunting-season or summer-outing villages. The evidence adduced is that the climate is the same now as when the villagers lived here. Moreover, then and up to thirty years ago all the precipitation was kept in the region, and the rainfall of to-day would sustain a large population if it was all used for crop production, as it was then, provided the people had as few wants as those villagers had and also made use of all the herbs of the fields and mountain slopes as even the Hopis do to-day. It is said that the Hopis now use 146 plants.

4. At the very time when the region was most favorable for their maintenance—a ponded, laked region—they left it.

5. The evidence adduced is that they were driven out or absorbed by more savage tribes. (See discussion on this subject in my previous report.)

6. The ruins in the region indicate that the civilization was at least in part built up in the region and later destroyed. The structures advanced from the crude type, through the slab-house stage, to the six-pilastered kiva and plastered, well-laid-up houses; and then, after the culmination of that civilization, it retrograded through the slab-house type to the Navajo hogan. There are Navajos at Sayaway, twenty-one miles east of Kayenta, now living in hogans very similar to the slab houses described by Kidder and Guernsey [2] A band of village Indians was incorporated in the Navajo or Ute tribe, voluntarily or as a result of war, and as time passed the pueblo structure of house of these absorbed people gradually changed to that of the savage peoples who were absorbing them. So that all stages of structure can be found between the six-pilastered kiva and the medicine lodge and living hogan of the Navajo and the dwellings of the Piutes, Utes and Apaches, depending on which peoples were absorbing that particular group of villagers.[3]

2. Kidder and Guernsey; Archæological explorations in northeastern Arizona: Bull. 65, Bureau of American Ethnology, pp. 41-46, 152, 153.

3. In building his house the Navajo adapts himself to the location and the scarcity of timber at hand and the amount and size of the fuel wood In the timbered region, say about Black mesa, the hogans are of the regulation type, such as described in the "Handbook on American Indians" (see vol. 1, pp. 515-519, and vol. 2, pp. 41-45); but in the non-timbered regions, as, for instance, at Donahotso and Sayaway, the hogan is circular and very small, often not ten feet across. The writer has seen them not six feet across. They are also sunk two or more feet in the ground and have a semi-cone-shaped roof over them. Some also have slab-stone walls, the flags set on end One at Sayaway has a sloping, one-sided roof, and one of the very smallest hogans there has a fireplace in the east wall. These circular, sunken rooms with conical roofs certainly resemble Kidder and Guernsey's slab houses very much in structure (see above). Other features, of course, are not the same; for instance, the door. A Navajo door is always at the east side of the hogan; the ancients had the door wherever convenience suited them. A more careful study of the Navajo house structure in the region might throw considerable light on the ancient ruins that dot the country from end to end.

Below is a description of the ruins examined in 1920 (the numbers beginning where they were left off last year):

No. 100. On a ledge on the east face of Tyende mesa, about a mile north of Cup rock, about six miles northwest of Kayenta and two miles southwest of Slim rock, there is a single-room ruin. It is built on a high shelf against the mesa wall. Its walls are semicircular. Its roof is now gone. Its greatest length is eight feet in a north-south axis. Its greatest width is about six feet. It had a very small door. Some corncobs were found in it; otherwise it was destitute of anything ancient. Its walls were of rock, well laid in adobe. The building had evidently been a granary.

THE KAYKOHTE RUINS.

A small stream, the Kaykohte wash, enters Laguna creek from the north just west of Moqui rock, west of the Kayenta reclamation dam. Its course is generally north and south. It is incised in a canyon wall in the valley fill, the outer walls of the valley being composed of Navajo sandstone. The valley canyon is usually much less than one-half mile in width. About four miles from the mouth of the stream it forks, and about two miles further north the east branch again forks. (To this time the writer has not ascended the west branch and not to the head of the east fork.) The stream and its branches are perennial and have clear water running in them most of the year, while many of the other streams of the region are 80 per cent mud. They also have perennial springs at their heads and at various places along the rock walls. There is now plenty of water for village use in the stream and in the various springs, also water for irrigating purposes. The Navajos have extensive fields in the valley, where they raise much corn, pumpkins and melons. As now, there was water in this valley in former times, besides in the long ago it was not canyoned up as now, the region being laked. At that time a numerous people of the village-cliff-house type lived and had extensive fields, as the ruins indicate. While they lived here the valley went under some change in the way of laking, as is evidenced by certain graves, as will be mentioned later. About a mile above Moqui rock to three miles above it many graves were made in what was then a sand plain. At a later date the region there became submerged in a shallow lake in which a deposit of marly adobe was deposited from three to ten feet in thickness. The canyon cutting is now exposing these graves, as we shall see later. Below is a description of the ruins north of Moqui rock to where the main stream branches, and then up the eastern branches as far as explored by the writer, except those described in my previous paper.

No. 101. This is a ruin on the east (main) fork of the east branch of this creek, about due west of ruin No. 100. It was not seen by the writer, but it was described to him by his Indian guide, Yellow Head. He stated it was a circular ruin in the open and made a considerable pile.

No. 101½. This ruin is on the west side of the west branch of the creek. It was not seen by the writer, but by his helper, Clarence Taptuka. It is a cliff cave. He did not believe it had been visited previously, as it was with difficulty that he reached it from the valley. He found a pot in it and several other artifacts. No excavating was done, so it is not known what it may contain. Its size was not ascertained.

No. 102.[4] On the west side of the east branch of the main creek, under a projecting, overhanging arch about three miles above where the creek forks, there is rather an extensive village with walls six or more feet in height. The village contains a gallery which was once at least two stories high and contained three rooms in floor length, all of a total length of twenty-four feet and a depth of from eight to ten feet. It is perched upon a ledge some ten feet above the main village and is unapproachable except by a ladder. Consequently, as we had no ladder, we could not examine it. The west end room seemed to possess at least a part of its roof; the others were roofless. The middle room's wall was much broken down at the front. Stubs of beams still stuck through the walls, which showed where the second-story floor was located. There also appeared to be portholes in each story, ranging the exposed field at various angles. There seemed to be much seepage at the top of the ledge on which this gallery was placed. Also in the rear of the rooms and back of them there was a box elder tree and much grass and weeds growing. and on the ledge above the gallery there were patches of green, usually of coarse grass. The gallery covered every available space on the ledge to its very edge. The first layer of the walls on the ledge was mortar Then alternating mortar and very small stones and shingle rock were used till the wall was leveled up. From here to the top the wall was made of stone, plastered in with adobe. So well was the work done that the adobe plaster even to-day is almost as hard as the sandrock it holds in place.

The lower building consists of a retaining wall sixty-six feet in length, extending along the very edge of the ledge on which the ruin is placed. Besides the retaining wall, it contains five rooms, marked from *A* to *E*, and some slight indications of two or three smaller rooms The rooms show rafter spaces or stubs of rafters in place, though no room is now roofed. Stubs or holes for beams for second floors also show in some of the rooms. Portholes for shooting arrows through also show, each made slantingly, so that the arrow could be dispatched in the desired direction. To get the angle desired, some of the holes angle quarteringly to the room; others pitch downward. Some also show the arrow marks of use. The walls were constructed much like those of the gallery. A peculiar feature of the mortar is that it is full of pottery fragments. Another peculiar thing about the ruin is that pottery fragments about it are scanty, and what there are could be from the weathering of the walls containing the pottery fragments, probably derived from ruin No. 103, next described. Also the painted pottery so far found is different from that of the other ruins of the valley. As stated, the pottery of the mortar must have been derived from ruin No. 103. If not from it, the whole village was reconstructed from the ruins of a former village on the same site, the refuse of that village being made into the mortar, as is indicated by the pottery fragments. This also may account for the scarcity of the pottery fragments about the site. Moreover. the retaining wall seems to have been built as such, as a fort protection and as a windbreak, as it apparently did not connect with any set of rooms by roofing for at least a part of its distance, with the exceptions of rooms *A* and *B*, in which the retaining wall was the outer wall of the rooms.

The village does not seem to have been completed and seems to have been

4. Rev. Leigh Segar aided me in examining and "mapping" this ruin.

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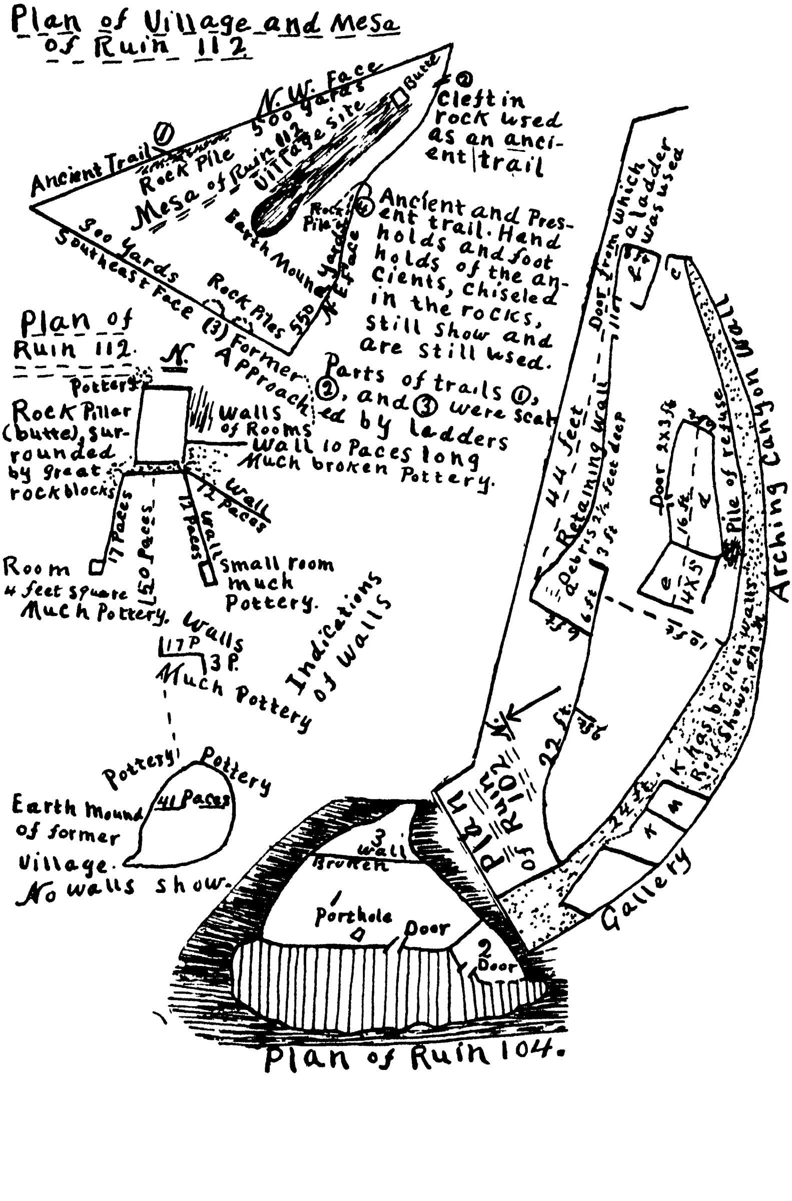

constructed as a fort. Moreover, it seems to have been used but little. If ever completed, its walls for the most part must have been wickerwork plastered over with adobe, as are some of the rooms at Keetseel and Betatakin. However, if such rooms were constructed, no trace of them can now be found. As stated, it is the writer's opinion that the edifice was constructed as a fort and was never completed. (See plan, plate 2.)

About 100 yards southwest of ruin No. 102, on the same ledge, which again becomes a shelf, there is a small patch of adobe-plastered stone wall, probably three feet in length, still in place. It is what is left of what was once a series of rooms fifty-four feet in length and probably five feet in height (the space height now) by a depth of five feet. Time has removed all this series but the single block mentioned. There is no permanent water within a half a mile of this ruin.

No. 103. This ruin tops a high sand-knoll point about one-fourth mile due south across a Navajo cornfield from ruin No. 102. On the southwest side of the knoll is a kiva in foundation in an imperfect circle of about eight feet across. One foot of stone wall still remains in place. It seems that there was once a door at the northeast side, which would exclude the edifice from being a kiva; but probably the apparent door space was the ventilator to the edifice. Near this building the fragments of what appears to be a cooking jar was found. Seven paces east of the kiva there is shown a wall seven paces long, running north and south, apparently having fallen to the west. On account of the work of erosion, the original size of the village could not be determined. Some one has dug much about the site, and especially about the circular room.

No. 104. (Pole House; see plan, plate 2.) This ruin is set in the rock face of a cliff high up on a ledge and can only be entered by climbing a pole. It fits a little hole in the rock wall of the mesa face, and was so constructed as to fill the whole space, some extra space being cut out of the rock to make the desired size. It consisted of three rooms, two front rooms and a storeroom in the rear. The walls of the storeroom are now much crumbled, as is the greater part of the wall of the smaller outside room. The size of room 1 (the large, west, outer room) is 14 feet in length, 5 feet in height and 8 feet in depth. Room 3 (the rear storeroom) is 5 feet deep and 3½ feet high. The southwest wall of room 2 (the east outer room) runs southeast from the southwest corner of room 1 for a distance of 5 or more feet and meets the roof ledge 4 feet from the base. Each of its other walls, which are about 4 feet in length, are much broken.

Thumb-nail marks show in the adobe mortar, also fingerprints. The shelf was also excavated and enlarged to make the space needed for rooms.

No. 105. Southeast of No. 104, on a sand ridge about 300 yards distant, are the remains of a village. Besides other debris, a circular room five feet across shows in foundation of stone. Near it two separate fireplaces show.

No. 105½. Across the canyon, eastward from No. 104, around a southwest projecting point about a half mile to the southeastward, there has been a large village perched under an overhanging cliff roof. The floor of the cliff cave, then as now, was on a level with the surrounding valley to the front. The village was large and seems to have extended in a large circle beyond the area protected by the cliff. The village is wholly obliterated except two

of the southwest rooms which stand against the cliff. Both of these were small and now are roofless. The doors of each were small. Only a part of the south room's walls are now in place. Besides these two rooms, parts of foundation walls of two other rooms show. In the sandrock base some twenty feet southwest of the two rooms are two very large mortars, separated from each other by a space of about ten feet. They are circular, a foot in diameter and a foot and a half in depth. They were undoubtedly used in grinding corn and in pounding nuts. The Navajos have used the site for a sheep corral and sheep droppings cover it to a depth of six to ten inches. Some one, presumably Doctor Cummings and archæological parties under his direction, has dug much about the site, especially in the area between the mortars and the two rooms mentioned. The digging shows much broken pottery, also chunks of roofing adobe which had been made into mortar before being placed on the roof. The thickness of some of these pieces also indicates that the walls of at least a part of the rooms were of latticework, over which plaster was spread, as is seen at Betatakin. Moreover, the fewness of the rocks about the site compared with the great amount of broken pottery—indicative of a large population having occupied the site—would seem to bear out the conclusion that much of the house walls was of plastered latticework. This village was long occupied and had a numerous population.

No. 106. Along the same canyon wall as ruin No. 105½, about a half a mile to the southwestward under an overhead, hooded, projecting cliff that faces the south, there has been quite a large village One small room against the east wall of the cliff is still extant, but now roofless. It has a very small door. A Navajo uses it as a lamb corral. He also lives under this cliff in summer. At the time examined he had a box of corn against the wall under the cliff, also much household goods piled upon some poles. He also had dug two cistern-shaped caves in the debris, where he had placed his perishable feed the previous fall. Shells of decayed pumpkins were strewn all about the site.

Against the back wall, 100 feet northwest of the room, are ten feet of a rock wall foundation of a room, and quite a distance west of this there is part of another foundation wall showing The village had been constructed of adobe, or latticework plastered over with adobe, all of which has for the most part been removed by time. The pottery about the site is scanty. The approximate size of the village cannot now be determined. Its site was an admirable location for a village in that day and time.

No. 107. (Picture Cliff Cave and Village) On the same side of the canyon in a little *rincon*-curved area facing the south, about a half a mile south of No. 106, is a large cliff cave space that once possessed an adobe village of considerable size, all of which has now been leveled by time. About 100 yards southwest of the cliff cave there is quite a mound of a village ruin. From the mound the writer obtained much beautiful pottery fragments, also several *manos*. Over the cliff space there is drawn in white the figure of probably a lizard, or a human being sporting a foxtail pendant. This drawing is about two feet in length. Also, the whole rock face to the westward of the cave space to the width of 50 feet and a height of 20 feet is covered with pictographs, principally of mountain sheep, coiled lightning, and kachinas. The size of the village or villages that occupied this site cannot now be conjectured.

No. 108. This was a village occupying the top of a sand mound in the open, about a mile southwest of ruin No. 107. Its site is marked only by broken pottery. Time and erosion have removed so much of the site that no idea of the size of the village can now be suggested.

No. 109. Much broken pottery marks the site of a small village in the valley about a half a mile nearly south of ruin No. 108.

No. 110 These are patchy remains of what was probably an adobe village or graveyard on the east bank of the wash (Kaykohte), that enters Laguna creek to the west of Moqui rock about one and a half miles north of that rock. The encroaching creek has washed most of it away.

No. 111. This is an extensive ruin on and about a promontory east of the Kaykohte, about a half a mile south of ruin No 110 The ruin was very extensive and was built of stone On the promontory there was evidently a large edifice, which was probably the watchtower citadel. At the base of the promontory on all sides are signs of an extensive ruin, now represented by foundations of rooms in regularly arranged lines of foundation stones and much rock debris and broken pottery. The original floors of the rooms, with the ashes in the fireplaces, still occasionally show; also terraced platforms, where the houses were built from the base of the promontory to its top, still are in extant. The base of this village is also on a rock bench overlooking the valley from a height of probably fifty feet Moreover, in the valley adjacent there are signs of a village once occupying the site. An arched place under the west face of the rock bench there contains many pictographs on its walls and the outlines of ruins at its base. Probably 300 people lived in the combined villages represented by these ruins.

No. 111½. On the east side of the Kaykohte, along its immediate bank and extending from there eastward opposite ruin No 111, from Moqui rock northward for over a half a mile there is much scattered village debris. No walls show, but large quantities of broken pottery, metates and *manos* are profusely strewn about. At least three village sites seem to be represented, and as many graveyards The villages were of adobe and have "melted down" with time and are now wholly gone. If occupied simultaneously, at least 2,000 people must have occupied these sites.

Last spring my Hopi helper, Clarence Taptuka, discovered an exposed pot in the graveyard of the south one of these villages. Digging, he found that he had discovered a grave. Later he had me go with him, and we dug the grave down so that the skeleton was exposed, some two feet below the surface. The pot he had found was a large corrugated cooking pot. It was much broken, but in it were six other jars in a good state of preservation. The skeleton was also well preserved. It was the skeleton of a female. The large jar containing the smaller ones was at her head. Another jar, somewhat broken, was over her head. Her body was doubled and was lying on its left side, facing east, with the head to the south. Her knees had a cracked pot over them, as did also her feet. A cracked jar was also at her back. We secured the jars and carefully covered up the skeleton, knowing that Professor Cummings and the Arizona archæological party would be out soon. When they came the pots were turned over to them and are now in the state museum in the university at Tucson, Ariz. He then dug up the skeleton,

examined it and took photographs of the same. The archæological people then made a search of the region for other graves, finding many. As a result of these efforts and our discovery, much pottery and several complete skeletons were secured. The burials also showed that they had been made in a sand plain, as we have previously seen, and that at a later date the region was laked and a marly adobe deposited over them to the thickness of several feet. Then in recent years the renewed canyon cutting has exposed them. Whether the people of ruin 111 buried their dead in this flat cannot now be determined, but it is probable that they did. The writer wishes to add that there are probably hundreds of graves in this section yet unexcavated.

No. 111¼. These are pottery shards and some rock, marking the site of a village in the flat between Moqui rock and the mouth of the Kaykohte. It seems to have been a large village.

No. 111¾. This is the remains of a village similar to ruin No. 111¼, above. It is situated in the flat about 300 feet northwest of Moqui rock, not far from the last-named ruin. It is quite possible that the two village sites formed a single village in the old times, or were simultaneously inhabited.

No. 111 M. This is the site of a village one-sixteenth of a mile west of Moqui rock on a little knoll west of Kaykohte wash. Its debris, mostly broken pottery, covers an area seventy-seven feet square, with most of the pottery showing toward the south. Probably 100 people lived in this village.

No. 111 N. This is the remains of a similar ruin about one-sixteenth of a mile west of the latter ruin. The remains of a woman's grave near it shows five metates.

No. 111 X. This is the remains of a small ruin on a sand mound about a mile north of Laguna creek, some two miles north of the Peach orchard, on the Kayenta road to the pass. The village was small and was probably wholly of adobe, as nothing is now left on the site but broken pottery and some stained dirt, with the exception of a few fireplace rock which are not now in place.

REMARKS ON THE KAYKOHTE RUINS. Most of the villages described under this caption were made of adobe and have "melted down" and the clays have been leached away till now only a few scattered fireplace rock and much broken pottery and grinding slabs mark the sites. Some of the open villages show the unit type more or less, and some appear to have been built around a central round to square building in a compact, wheel style. Some of the sites seem to show evidence of a part of the village having been made of wickerwork plastered over with adobe mortar.

Besides the grave-excavation work of this past summer in this region, already mentioned, the writer has been advised that Professor Cummings and his archæological party from the State University of Arizona have done some work in examining ruins in this section, and the writer believes that the excavating that he has mentioned in and about some of the ruins was done by them. So far as the writer knows, however, no detailed description of the ruins of this canyon has as yet been given to the public by any one.

111 Z. This a small village site in the flat, though on a little sand mound about half a mile southeast of cliff-house ruin No. 35, on the north side of Laguna creek. It apparently was not large. No walls show. Much broken pottery is scattered about the place.

No. 112. This ruin (see plan, plate 2) is on top of a flat, triangular butte one-half mile southwest of ruin No. 35. On top of this butte, at the north-central part near the north apex, is a double rock pillar some fifty feet in height. About this are much borken pottery and immense broken rock blocks. On the east face of the pillar there are many pictographs of mountain goats (sheep), the coiled lightning, and one kachina. East of the pillar the village seems to have been built against it, or at least rather close to it. No ruins or debris now show to indicate that any part of a village was built against the west or north faces of the pillar, very large fallen rocks covering the space for quite a distance on these two sides. There is, however, considerable broken pottery on these two sides, which seems to have been placed in or under the rocks in this section in sacrificial offering. The village wall is built quite a distance south of the pillar on that side, probably for safety from falling debris from the pillar, and from the fact that some large fallen blocks of many tons each occupy this space.

From the cross east-and-west wall, south of the pillar, three projecting southward-leading walls can be traced in foundation in lengths ranging from twelve to twenty-nine paces in length, some of the walls showing a radial arrangement form a hublike center. At the terminus of the west wall line the outline of a room approximately four feet square shows. It had evidently been a stone-wall-inclosed room for storing sacred pottery, or a cist for burial, in which much pottery was placed with the dead. If used for the latter purpose time has removed all signs of bones from the debris. In it on the surface we found a cloud blower, a sieve pot used in the rain ceremonies, and parts of various other pots used in sacred rites, or at least like those now used by the Hopis in the ceremonies There were also several smoothed pebbles like those used by the Hopis in some of their ceremonies.

The middle room of the ruin that shows was about six feet wide by thirteen feet long. The debris inclosed in the rock walls of the foundation is now 18 inches or more in thickness. This room seems to have been a bin room where the large corrugated storage jars were kept, as the pottery fragments seem to be almost wholly of these jars. The writer found two jars that had been tipped over and mashed flat, so they could not be saved. A pot smoother, used in smoothing pots in the making, was also found here. It was of a fragment of pottery about the size and shape of one's hand without the fingers. It has been much worn down in the pottery-smoothing process.

About 150 yards south of the rock pillar there is quite an earth mound, circular, and forty-one paces in diameter. It is apparently the debris on a "unit type" adobe village. No walls show. Much pottery is scattered about it. Also between the mound and the pillar there are several detached remains of foundation walls of rooms and also considerable shards occasionally, though now it cannot be certain that the village was continuous from the pillar to the mound. It would seem that the citadel was by the pillar and was of rock. The village home was that part now represented by the earth mound and the adobe parts between the citadel and the mound, now washed and blown away.

The top of the table on which this village is situated is wholly bare, except the mound site, and probably was so in the days of the village. The earth of which the village was constructed was carried up the rocky face to the top

of the table from at least a half mile distant, and must have necessitated an immense amount of labor for that day and time. The table on which the village was built is itself fifty feet or more above the plateau on which it is situated. In ancient times it was approachable only by four trails, three of which were partly by ladders, and the fourth could be climbed only by pecked handholds and footholds. Also, three of the trail approaches show piles of rocks that were used there for defense to bombard approaching enemies. The village was evidently built on the top of this isolated mesa for defense, and as such it was admirably situated

It is the writer's belief that it was one of the fort locations that was used by the people who lived in the valley flats along Laguna creek in times of peace. The pottery found was in large pieces, which would seem to indicate that it was likely one of the places where the villagers made their last stand in the region and was probably one of the last abandoned. Probably 250 people lived in this village

The site was pointed out to my helper, Mr Taptuka, by our guide, Yellow Head, but was not visited that day, as it was too late to make the ascent from the valley. On the following Sunday, in a sand storm, Mr. Taptuka and one of the schoolboys visited it Later then the writer visited it several times in company with Mr. Taptuka It is the writer's opinion that he is the first white man ever to visit it

No 113. This was a small village—a few houses perched against a rock face in Laguna canyon at the foot of Man Head point northeast of ruin No. 21. Some pottery marks the site, also pictographs One of the pictographs is that of a kachina scene The village was small

No. 114. This is the ruin of a village about two miles up the Segi, above the pass It is in the flat north of the creek about a mile west of the first arroyo that enters the creek from the north on ascending the valley from the pass. About forty feet of the west wall foundation of the village is still in place The foundation was at least partly of stone. The remainder of the village was undoubtedly of adobe, judging from the scarcity of rock about the site. Much of the original site has been carried away by the cutting back of a short stream draw. Much broken pottery, some pieces of large size, mark the site. The size of the village could not be estimated from its present state.

No. 115. This is the remains of a village on a knoll about one-eighth mile southwest of Swallow Nest ruin. It seems to have been a large village. Some rock and considerable broken pottery mark the site.

No. 116. This is a village across a little draw, around a point southeast of Sayaway (Baby rocks), twenty miles east of Kayenta. The writer saw it when taking care of the people sick with the "flu" in 1918, and also when securing school children in April, 1920, but on neither occasion could he spare time to examine it. It seems to have been a rather large village. Adjacent to it to the eastward and northeastward is the large flat of Laguna creek. There are springs in the foothills of the McElmo mesas to the southeastward, where the Navajos now obtain their water for house use. It is quite likely that water was impounded in these draws in the old times. The place was very much handicapped in the way of a wood supply. The only wood within miles of the place is greasewood brush, and it seldom gets more than two feet in height. The Navajos raise quite a bit of corn in the section now, and by

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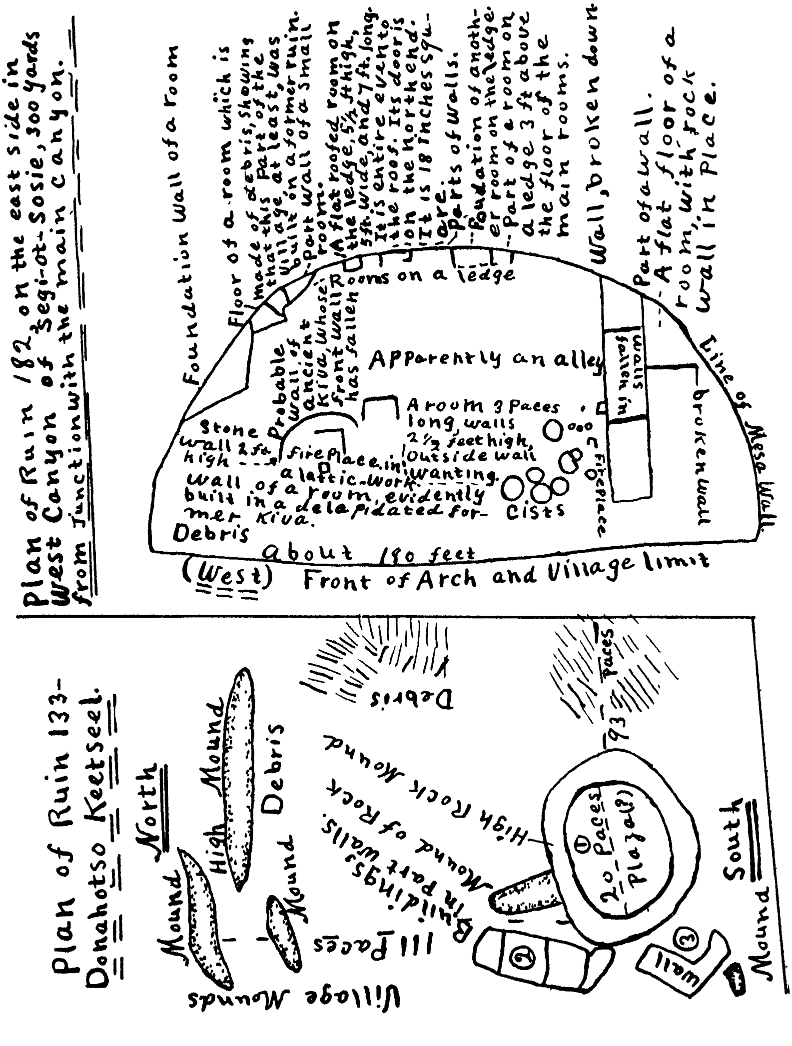
PLATE III.



the better irrigating system the villagers undoubtedly raised large crops of that plant.

No. 117. This ruin is one mile east of the government hay meadows and the ruins previously described near there, ruins Nos. 46-51. It is small. Some rock and much broken pottery show. It was built on a black dirt flat, and probably was the house of a single family.

No. 118. This ruin is in a sand-dune region about a mile east of ruin No. 117. It is just east of the Chilchinbito-Kayenta wagon road. It was a very small village. Some rock was used in the construction. The pottery fragments are in small bits. Probably not more than five families ever lived on this site at any one time. This village and No 117 appear to be very ancient. They both owe their existence to the government hay-meadow flats and the water impounded in them, the same as the ruins described in the region in the 1919 report.

No. 119 Over in the second flat, about a mile west of the ruins at the spring north of Chilchinbito, described in the paper of 1919, are the remains of a ruin now wholly reduced to the level, and its pottery is also broken into small bits It therefore seems to be very ancient.

No. 120. This ruin is of a village on top of a small butte and surrounding it, principally to the south, about a mile and a half west of the spring north of Chilchinbito store Also, about 100 yards east of the butte are the remains of a village, now reduced to the level. Some of the rocks used in this village and the village about the butte are still lying about them, the most being on the site of the village about the butte. There is also much broken pottery about the site. A large grinding slab from one of these ruins has been placed against a tree near the trail that passes the butte.

No. 121. This is the remains of a ruin reduced to broken pottery and rubblestone It was situated on a ridge—at least the site now is—between two washes about one-fourth mile northwast of Chilchinbito spring, as the writer formerly called it.

No. 122. This ruined village is now being exposed by the shifting of dune sand along the north road from Chilchinbito store to about one-half mile north Much small, fragmentary pottery marks the site. The scattered pottery indicates that it was probably a large village. The small pieces would seem to indicate that is is very ancient.

No. 123. (See plan, plate 4.) The ruins represented by this number are one-half mile northeast of Chilchinbito spring, as the writer gave it in his former report, now known as Tothlacon spring. Three separate villages show, designated (*a*), (*b*), (*c*). Ruin (*a*) is on top of a small promontory of probably 100 feet in length. Much pottery and rock of the walls still top the butte ridge; also two kiva depressions show. Ruin (*b*) is about 100 yards east of (*a*), in the sand-dune region adjacent to it. It was built partly of stone. Parts of the wall of one small room still stand, 3½ feet in height; it was of stone. The east-and-west wall is 6 feet long, the north-and-south wall 5 feet. Ruin (*c*) was a village about 200 yards north of (*b*). A mound of stone marks the site. The lines of some east-and-west walls show. The village seems to have been of the unit type. Probably 300 to 500 people lived in these three villages.

No. 124. About one-fourth of a mile a little east of north from ruin No.

123, out in an open sand-dune area, much pottery of large size is exposed; also some building stone and wall lines show. The foundation of one circular room less than 5 feet in diameter is conspicuously exposed.

No. 125. This is the remains of a village, or series of villages, that once occupied some buttes about one-eighth of a mile north of ruin No. 124. The buttes are not high, the highest being less than 25 feet in elevation; but their commanding position overtowered the valley to the northward. The west butte is an irregular square, probably 20 feet to a side. Rock foundations still in place show that every inch of it was built upon, to its very margin, the edifice probably being a watchtower. Much broken pottery marks the site. The building rock scattered about indicates that a village or villages was built around the buttes.

Ruins Nos. 119 to 125[5] were all dependent upon Tothlacon spring and the impounded water in the flats to the westward for their water supply and for the irrigation of their crops, the same as the Chilchinbito ruins, previously described.

No. 126. Three small mounds were found on a sand ridge on the first bench north of the wash west of the Chilchinbito volcanic plug, about two miles northwestward from ruin No. 125. They were approximately in an east-and-west line and less than 400 yards apart. Each carried village debris in partial walls, and much broken pottery. They apparently had been separate villages, and each probably had about 100 inhabitants.

No. 127. This is a small ruin 300 yards north of the road, about a mile northeast of Church rock. A small mound of rock marks the center of the site. Lines of rock seem to indicate that some of the rooms were rectangular. Some pottery fragments are scattered about the site. Probably no more than fifty people ever lived in this place at any one time, and probably not half that number. This village appears to be of the circular ruin type, and probably of the pure type village as defined by J. Walter Fewkes.[6]

No. 128. North of the road, near the first point projecting northward into Laguna valley from the south, to the east of Church rock, there is a small mound (cluster) of rock, and there seems to have been a village of adobe about it. Probably fifty people lived here. The outlines of a fireplace show in the mound and some pottery fragments are scattered about the site. It appears to be another circular village, probably built around a towerlike kiva.

No. 129. A ruin similar to No. 128 was found on the south side of the road one-eighth of a mile east of the above-mentioned point. It was small and less than fifty people lived in it. Its center is now a pile of rock, around which adobe structures were apparently built, the rock pile representing the citadel-kiva part of the village.

No. 130. A small village was found about one-eighth of a mile southeast of ruin No. 128. It was of similar construction and was small.

No. 131. About two miles west of Sayaway (Baby rocks) and 100 yards south of the road an elongated village ruin was observed. It is 63 feet in

5. About 200 yards northeast of ruin No 125 the writer found a vertebra of a dinosaur (?) near the trail as he was descending from the ruin to the valley. The vertebra has been presented to the geological department of the State University at Tucson, Ariz.

6. Fewkes, J. Walter; Prehistoric villages, castles and towers of Southwestern Colorado, pp. 31-39.

length by 30 feet in width, laid out in an east-and-west direction. Some stone of the foundation walls still occupy the site.

No. 132. This is a small ruin north of the road, not far from ruin No. 131. It has the central mound of stone, representing a central building, around which, no doubt, adobe structures were erected.

No. 133. (See plan, plate 3.) This ruin is called Donahotso Keetseel by the Navajos. It is the most massive structure built in the open yet seen by the writer. It is built on an irregular, low sandstone ridge southeast of Laguna creek flats, at the head of what is now known as the Donahotso cornfields of the Navajos. There are also indications in leveled areas that more extensive fields were farmed in the time of this village than now by the Navajos A strange thing about this ruin is that it could have been built on a level-topped, elevated mesa not one-eighth of a mile distant to the northwestward, also in the valley, and could therefore have had the protection of the elevation. Moreover, on this flat-topped mesa there would have been a level place to build on. About a mile to the eastward there is another large, high mesa on which they could have built.

The ruin seems to represent two different periods of occupation. For a long time the whole area was used as a building site, then was abandoned. Then in a more recent time, judging from the appearance of the ruins, the sections 1, 2 and 3 were built of the old debris and occupied for a short while

The ruins are of rooms built of white limestone that was carried from the top of the mesa a mile to the eastward, and the massive pile of stone must have necessitated an immense amount of labor. Many rooms still show in sections 2 and 3, the walls often being five feet high. The sections marked 1, 2 and 3 appear to be modern in construction. They look about as ancient in age as the ruins about the Spanish church north of Jemez Springs, N. Mex., that was abandoned about 1680. Probably 500 people lived in the last-built sections and 1,000 when the whole area was occupied in the remote time.

In 1894 Richard Wetherill did excavation work in this ruin, but so far as the writer can learn, no published account of his findings are extant.

The ruin as seen now lies at the head of the flats in which the Navajos now have their cornfields, the same being irrigated from the waters of Laguna creek, adjacent—a giant task to be done wholly by Indians without any aid from the government. As stated, the flat, leveled lands in the vicinity indicate that these Pueblos farmed a much larger area than is now farmed. The intensive irrigation in the upper reaches of the Laguna valley probably caused the abandonment of this region, on account of the shortage of water. Though for a smaller population the rains in the immediate vicinity would have been sufficient to furnish water for irrigating purposes, provided it was impounded, and there are indications that it was.[7]

The ruin seems to have been built of hard limestone for durability and for defense. Moreover, the only defense the village had was its walls.

No. 134. Around the point of the mesa on the eastern edge of the flats, about two miles east of ruin No. 133, a large ruin is represented by great

7. Laguna creek, now fifty feet down in a chiseled canyon in valley fillings, was so shallow that one could jump across it in the memory of children now attending the Marsh Pass school.

quantities of small bits of broken pottery scattered here and there in the shifting sand. The village was evidently built of adobe. The small bits of pottery seem to indicate that the village was very ancient. Probably 200 people lived in it.

No. 135. About half a mile east of ruin No 134 is a village of similar size to the latter and in about the same state of delapidation. It is therefore undoubtedly very ancient.

NOTES AND REMARKS ON RUINS NOS. 128-134. As has been noted, these ruins are in Laguna creek valley, east of Kayenta. They are also all on the south side of the creek. A ruin on the north side will be described later. These ruins were all seen on a trip to Donahotso for school children. Little time was at hand to examine any of them. The most time, possibly an hour, was spent at Donahotso Keetseel while the horses were resting and eating. The valley here is wide and would make good farm land if there was sufficient water. In the old times the creek, if it existed at all, was not canyoned up as now and all the water that flowed through the valley was available for irrigation. Now the valley is a sand-dune, sagebrush, greasewood region.

Many of the smaller ruins of this valley appear to be of the circular ruin type, apparently built around a tower kiva in radiating, peripheral style. The central building was usually of stone, or at least partly of stone; the rest of adobe or wickerwork plastered over. The outer rooms seem almost always to have been of the latter make. At least no foundation walls show now, though pottery is profusely scattered about.

No. 136. This is a small ruin in the last valley north of the government hay meadows. It is about two miles about due west of ruins Nos. 46 to 51. It is in a wash at the foot of the trail that leads up from the foothills to the east to the top of Black mesa at this point. It was built in the inner canyon valley, and no doubt had a dam across the canyon at this point for the impounding of water. It was a very small village and was built of rock. A small mound and considerable broken pottery mark the site. Probably twenty-five people lived in it. It shows evidence of having been occupied for a considerable time. It probably was a watch village in the trail that led to the cliff village on top of Black mesa, some three miles to the southward, as will be described later.

No. 137. In Laguna creek valley, about half way between the Peach Trees and Black mesa, on the south slope of an east-and-west low bridge some seven seven miles west of Kayenta, there is a ruin. It is now reduced to scattered rock and some pottery. It represents a small village that probably never contained more than twenty-five people.

One-fourth of a mile east of ruin No. 137 there is a small mound and some scattered pottery fragments. Either a single-roomed house or the remains of a grave is represented here.

Also, about one-fourth of a mile southeast of the Peach Trees there is a small stone mound, probably the remains of a single-roomed house. Considerable pottery, is scattered here and there over quite an area east and south of the mound, but in no great quantity in any one place, and there is no indication of any other village site near. The village, or house, was probably of adobe construction, outside of the building stone that now makes up the mound, all of which has been removed by time. If a village it could never have been large, and evidently was not inhabited long.

Between ruin No. 137 and the Peach Trees, at about half the distance, there is a small knoll. On this there are indications that a small village once occupied its summit.

No. 138. This is a small mound of rock just north of the Marsh pass wagon road, about three miles west of the Peach Orchard. Much pottery is scattered about the site. The village seems to have been built in circular form, though time could not be had to examine it definitely on this point. Probably twenty-five people lived in this village.

No. 139. A small mound of a ruin was seen south of the road about half way between ruin No 138 and where the road mounts the rocks at Marsh pass. It seems to have been circular, around a core room, and to have been built mostly of stone.

No 140. (See plan, plate 4) Along the north wall of Segi canyon, just as the wall makes the turn westward from Marsh pass, there is a shelf ninty feet in length, overtowered by an arch of Navajo sandstone. The shelf is narrow, but wide enough to have been used as a house site in the long-ago. On this shelf there is a line of debris of fallen walls. The front wall of one room remains one story high. Other walls, and foundations of other walls, can be made out, as shown in the plan. To the east of the shelf there is also a cave. The writer had passed the place time after time and had not noticed this ruin till May 6, 1920, when a suitable sun revealed it. It is not mentioned by Kidder and Guernsey or Cummings, each of whom did extensive work in that section A hundred people probably lived in this village.

THE LONG VALLEY RUINS.

In the writer's former report he gives some of these ruins on the map in X marks, but does not describe them, as at that time he had not examined them. On the map he stated that they were seen by Kidder and Guernsey. Moreover, on their map[8] they are marked by a "—," but are not described at all in their paper. Their remarks on the valley and its ruins are as follows [9]

"Leaving Kayenta, one follows this (Kayenta-Tuba) road up the broad valley of Laguna creek, with the high, dark cliffs of the Black mesa on the left. After eight or nine miles the valley narrows, as the slopes of Skeleton (Segi) mesa close in from the north and west. A mile or more and one reaches Marsh pass itself, a narrow, rough defile, bordered on each side by high cliffs. On the right is the mouth of Segi canyon, a majestic red gorge with precipitous walls. Another mile and one is clear of the pass and in the most beautiful, long, grassy valley (Long valley), half a mile to a mile wide, walled in uncompromisingly on the south (east) by Black mesa and bounded on the north (west) by sloping ledges of red sandstone. . . . The scant drainage from this defile runs down through the pass, where it is joined by a more constant flow from the Segi system, the two forming Laguna creek and ultimately emptying into the Chinlee.

"Although there is no flow of water in these upper reaches of Marsh pass comparable with that of Segi canyon, there is a plentiful rainfall at certain seasons of the year. Every storm that crosses this part of the plateau seems to swing along the face of the Black mesa and deliver part of its rain upon the valley. The vegetation, while strictly of the dry-country type, is more

8 Loc cit, plate I.

9. Loc cit., pp. 55-56, 90.

luxuriant and varied than about Kayenta and The Monuments; particularly is this true of the little side canyons that lead into the red sandstone on the northern (and western) side, where hollows and pockets in the rock hold supplies of stored rainwater so large that they probably last through the dry seasons of all but exceptionally dry years.

"The valley is a level plane covered with bee plant, grass, sage and greasewood. Its southeastern wall, as stated above, is formed by the steep, rough, pinyon-clad face of the Black mesa. The rise of the northwestern escarpment is much more gradual, and its total height considerably less. It consists of tilted sandstone strata, sparsely wooded with the inevitable pinyon and cedar. Along the base of these slopes are mounds and hummocks of sandstone, some bare, some drifted over with dunelike accumulations of sand. This whole northern side of the Marsh pass valley, with its warm southern and southwestern exposure, abundant water holes, and broad sweeps of good adobe soil for corn culture, must have been well situated for the homes of the ancient agriculturists, and the remains of their villages are scattered thickly along the edge of the flat land, from the lower gorges, where Segi enters, to the point three miles above, where our exploration closed."

In their report of 1915 they again make report on this region, as follows:[1]

"A short time was spent in examining surface ruins above the section explored in 1914. They were found to occupy practically every desirable site on both sides of the valley to its head, and were also scattered through the pinyon growth on the first bench of Black mesa. As a rule, these ruins are much dilapidated, few walls showing above the surface, though it is probable that considerable portions of the foundations or other walls may be covered by sand and earth There appears to be no difference between the pottery from one ruin and that of another, except that about the villages at the foot of the valley red ware seems to predominate, while at the upper end black-and-white and red occur in nearly equal quantities."

The valley is the result of a stripping of the Cretaceous (Dakota, Mancos and Mesaverde) rocks of Black mesa off of the harder Navajo sandstone of the Jura-Trias series to a wedge-shaped trough—all the rock in the region dipping eastward at a high angle—and then the aggrading of this trough with valley fillings to a wide, flat valley. It is called Long valley from the Long House ruin (Ruin A of Fewkes, Kidder and Guernsey, Cummings, and the writer), which tops a stone promontory about a mile southwest of the pass on the west margin of the valley. It is about six miles in length and from a mile to two miles in width. Its drainage is northward-northwestward through a wash to Laguna creek, entering it through a gorge. The valley is now being cut up much by gorges and washes and much soil is being carried away.

In this valley there are 2,000 acres of as good land as there is in the west, and in the days of the villages every bit of it was farmed, and then every bit of the water was impounded and used. Sites of reservoirs and dams show at intervals throughout the whole valley, even into the pass itself. To-day a fine reservoir project could be had at the foot of this valley. The damming could be done where the wash enters the gorge to descend to Segi canyon. Its channel there is narrow, the walls high and wholly of solid rock, and there is plenty of rock at hand to do the damming. Even for stock raising, a dam there that would impound the water would be a boon to the region. That the valley is a mudhole half of the year the auto drivers of the region will attest; besides the snowfall in the section is usually heavy. Four feet of snow

1. Loc. cit., p. 90.

fell in the winter of 1918-'19 and nearly the same amount in 1919-'20. Two thousand acres of land would produce crops there to-day without irrigation, if properly handled, while a Navajo has 10 to 20 acres under cultivation. The rest of the region is overrun by sheep and goats. In the summer of 1920 the weeds were as high as a horse over nearly the whole valley.

So far the writer has examined only a few ruins east of the road, as time would not permit the examination of the ruins on the east side of the valley. The ruins examined this year are given below in detail:

No. 141. This is a small mound of rock representing the ruin of a small village that was directly eastward from ruin B across the valley, probably one-half mile distant. Considerable pottery is strewn about the site. Probably twenty-five people lived in this village.

No. 142. This is a ruin about 100 yards northeast of ruin No 141. It is of similar size and character to that one.

No. 143. This is the remains of a village on the east side of the road, about two miles southeast of ruin A. It was evidently of adobe, and was small. Only pottery fragments mark the site to-day.

No. 144. This is the ruin of a large village which occupied a sloping point and a detached rock mound about one-half mile southeast of ruin A.[2] Much pottery marks the site, and some signs of walls also show. Probably 150 people lived in this village.

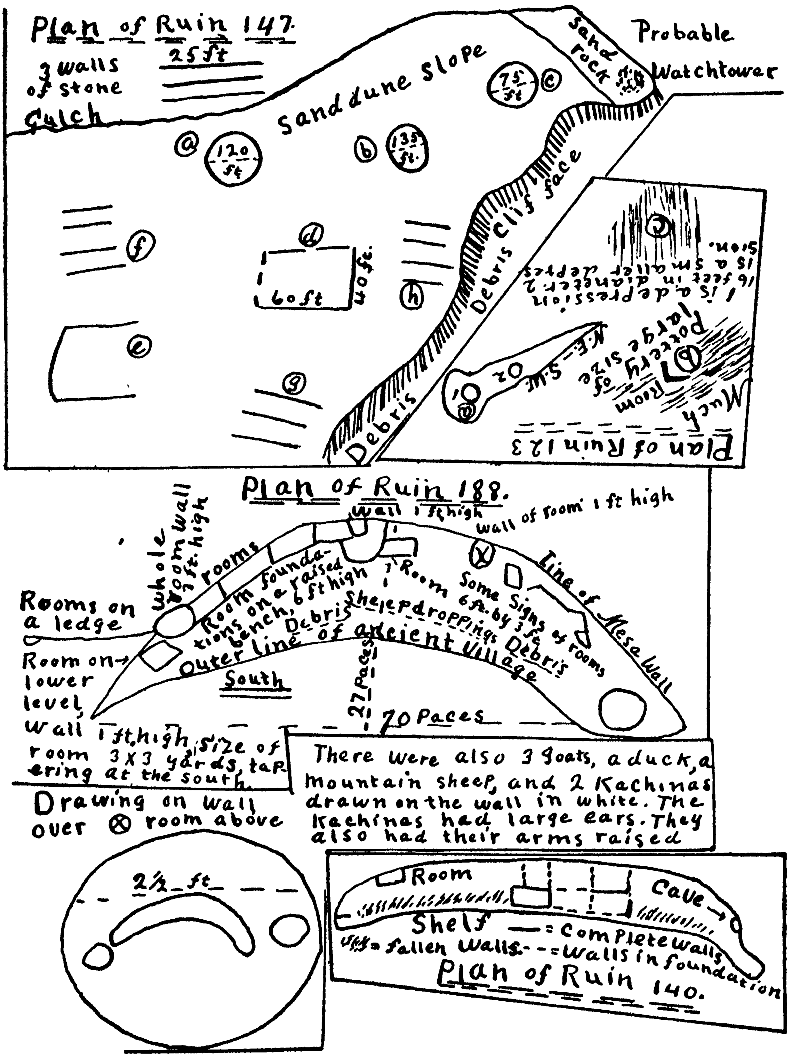
No. 145. This is a ruin in the open and a cave one-fourth of a mile southeast of ruin No. 144. The cave floor is on a level with the valley, and it has recently been swept out by the wash that flows by it. Just south of it much broken pottery and other village debris are exposed, both upon the sandstone point and in the valley filling adjacent The size of the village cannot now be conjectured, except that it was large.

No. 146. The debris of a rather large village covers quite an area about one-half mile southeast of ruin No. 145. It is on a sloping point and on the sand dune that abuts it to the southeastward, while a tower probably occupied the summit of the rock point. The valley here makes a pocket to the westward, and it is on the cornering point north of the pocket where the ruin is situated. A wash sweeps past the point and has probably removed much of the original village. What appears to be two sections of the village can be distinctly made out, one on each side of the point, but no arrangement of the village could be determined. Much debris is also being uncovered by the wind in other sections. Probably 500 people lived in this village.

No. 147. (See plan, plate 4.) This ruin covers a sand dune that slopes downward to the valley from a point of sandstone that stands between two gulches. Also across the gulch to the southeastward three parallel stone walls running in an east-and-west direction stand out from the parallel cliff wall to a height of from 5 to 7 feet and from 20 to 25 feet in length. They are built on a terrace. Consequently, the walls are higher than each other accordingly as their position is above or below their fellows. Besides this wall, on the dune there are remains of three circular villages, two rectangular ones, and three places, marked (*f*), (*g*), (*h*) on the plan, where much village debris is exposed, each probably representing a village site.

2. Ruins A and B were described in my previous report, which see.

TRANS. KANSAS ACAD. SCI., VOL. XXX. PLATE IV.



(*a*) On the plan, (*a*) marks a circular village 120 feet in diameter, with a raised border, representing the walls, and a 2½-foot depression, representing the plaza. Its walls were of stone and quite thick. It has the appearance of being a younger structure than any of the others of the site, except possibly the parallel walls. This, however, is merely conjecture. In some respects this circular ruin resembles a giant kiva. Only excavation would determine its exact status. It seems, however, to be too large to have been a kiva. Moreover, its walls seem to be wide enough from the plaza sink to the outer rim to have been a series of rooms.

(*b*). This is a circular ruin very similar to (*a*). Its rock pile, representing the ancient walls, is highest at the north and northeast, though at no place is the mound so high as the circular mound of (*a*).

(*c*). This is a similar circular village 20 to 30 feet above (*b*), at the summit of the sand dune. The elevated circular rock mound here is not so conspicuous as in (*a*) and (*b*), but the central depression is more pronounced than in those ruins.

In many respects, as previously mentioned, these circular depressions, with outer wall rims, resemble kivas; but if they were such they were of giant proportions compared with the usual size of kivas of the region. Moreover, as we will see later on, there are circular villages in the region where the circular structure was the only edifice erected. Furthermore, the abundance of pottery would seem to indicate that each was a village and not a kiva

(*d*) and (*e*) These are rectangular structures, as is shown in the rectangular foundations which still remain partly in place The buildings were constructed of rock Ruin (*d*) is about on a level with (*a*), but much below (*b*), and (*e*) is much lower down on the sand dune than (*d*).

If this village site was all occupied at one time, between 400 and 700 people must have lived in it. If the circular buildings were kivas—as only excavation of course, can determine—they represent the gathering of a great population to this center. As stated, the evidence seems to show that each represents a circular village, or a circular segment of the whole village, if the whole area was inhabited at one time as a single village. It is the writer's opinion that the whole site was not simultaneously occupied.

No. 148. This is a ruin on a point of rock which projects into the valley a considerable distance southeast of ruin No. 147. It is circular, 123 feet in diameter, and shows quite a plaza depression. The pottery is scanty about this site, which would indicate that the edifice was possibly a kiva. No other signs of a village shows within a quarter of a mile of it.

No. 149. This is a small ruin on a projecting point, represented for the most part by scattered pottery.

No. 150. This is a considerable mound on a point, about which much broken pottery is strewn.

No. 151. This is the ruin of a small village on an isolated bit of rock out in the valley. The ruin was probably a watchtower. Some foreign rock was used in the construction. The pottery fragments about this site are scanty.

No. 152. This is a ruin on a point projection about a mile southeast of No. 151. Considerable pottery marks the site.

No. 152½. About a mile north of the divide (Cedar ridge), about 1¾ miles

northeast of Summit lake on the north side of the road, is the remains of a small village, evidently having been constructed of adobe. The ruin is just east of the first point of bright red rock west of the road (probably McElmo rock). Broken pottery mostly marks the site.

No. 153. This ruin is on a small point projection that projects into the valley from the west, about one-half mile southeast of ruin No. 152. The west-line wall still shows in the foundation, 42 feet in length. From this wall to the eastern limit of the pottery is 130 feet. The plaza or kiva still shows as a depression. Much broken pottery still marks the site and extends far down the slope.

No. 154. Out in the flat one-fourth of a mile from the west edge of the valley, one-half mile east of ruin No. 153, is a double ruin—a heap of stone—about which considerable pottery is strewn. The two mounds are in a north-and-south line with a space of twenty-five feet between them. Probably twenty people lived in each section of this village.

No. 155. This is a small ruin just north of a Navajo cornfield, about a mile north of ruin No. 156 (next described). The ruin is nearly all washed away. Considerable pottery fragments show. Possibly the ruin is on the upland and the pottery is wash material from it.

No. 156. This ruin is on a small stone ridge covered with sand, which projects into the valley on the west side of Long valley about a mile north of where the wagon road enters the valley from the mesa to the westward. Much pottery and some building stone mark the site. Probably 100 people lived in this village.

Ruin No. 157 is on the mesa bench inland, and ruins Nos. 158 to 160, including No. 158½, are on the east margin of the mesa bench overlooking Long valley from the west. All five of them are south of the road. The last four were probably placed on the mesa rim to overlook and guard the valley.

No. 157. This ruin is 400 yards south of the road on the bench one-fourth of a mile west of where the road descends into Long valley. It is on a low, flat-topped, circular knoll, 135 feet in diameter. About it pottery is being exposed. Prairie dogs are digging up the pottery. The flat top has a raised border now and then. The knoll is in the pinyon wood, where it is not disturbed by wash and wind. It is the writer's opinion that a circular adobe ruin remains there *in situ,* so to speak; in fact, it has all the appearance of being a typical circular ruin, which once possibly had peripheral compartments.

About 500 yards west of this ruin quite a quantity of pottery covers the surface, but there are no signs of a village. The pottery probably represents a grave.

No. 158. This ruin is on the east margin of the mesa, west of Long valley, as we have seen. It is 130 paces south of where the Tuba-Kayenta wagon road descends into that valley. A kiva 35 feet in circumference seems to be represented by a circular depression. The structure had been of adobe. East of it, down the slope, there is much broken pottery, indicating that the village that surrounded it was quite large. The village had also been of adobe and probably contained 100 people.

No. 158½. This is the remains of a village on the rim of the mesa about half way between ruin No. 158 and the wagon road. It was probably as large

as that village. Much broken pottery is being exposed on the rim and shards cover the whole slope to the valley.

No. 159. (See plan, plate 6.) This ruin is along the same face of the mesa, overlooking Long valley, 186 paces to the southward from ruin No. 158. It differs from that pueblo in that it was made of stone. The circular foundations of a kiva 24 feet across still show. Twenty paces south of the kiva the stone foundations of a long room still show, 22 feet by 10 feet, running in a northwest-southeast direction. Abutting the southwest corner of this building is a part of a circular foundation of rock of what was probably a small kiva. The circle shown is 12 feet across; also parts of other walls show. The plaza depression is 2½ feet deep. Much pottery marks the site and covers the slope east of it all the way to the valley.

No. 160. This is a circular village ruin three-fourths of a mile southeast of ruin No 159. It is 54 feet across. Some pottery marks the site and much fragmentary pottery covers the slope to the eastward In many respects it looks like a large kiva, and now shows a depresson of 3 feet in its center, though this can be accounted for by the raised rim due to fallen walls. Only excavation will determine whether it is the remains of a small circular village, around which temporary peripheral adobes were constructed, or a large kiva to a large village which has been washed away by the shifting of the mesa rim on which it was located.

RUINS ON THE MESA FLAT TO THE WEST OF LONG VALLEY.

Ruins Nos 161 to 174 are on the mesa west of Long valley. The ruins seen were just those along the road. These were seen while Mr. John Schwarz and the writer were working the road from Calalmty's hogan to Marsh Pass. About one mile from where the road climbs onto the mesa from Long valley there is a shallow basin north of the road, known as Summit lake, now dry most of the year. About three miles west of this lake, one-fourth of a mile to the north of the road, there is a large pool-like lake which has water in it more of the year than Summit lake (it was not dry at all during the summer of 1920). Its holding water better is due to the fact that the former lake now has a wash leading out of it to the eastward, which cuts down its collecting capacity. Also, to the westward of the pool washes enter the valley, and, spreading out, lose their water. These were probably dammed in the long ago, as villages were erected along them. The country is flat, with a knoll now and then. It is a mesa valley from three to ten miles wide. It is bordered on the east and southeast by the Cretaceous block of rock known as Black mesa, and to the north and northwest by the more gentle-sloping Navajo sandstone of the Shonto plateau. Leveled spots show that much of this flat mesa bench was farmed in the old times, and Navajos even now raise considerable corn in the area.

No. 161. This ruin is on a little knoll just south of the road, about east of Summit lake. Some rock was used in the construction. Much pottery is strewn in fragments about the site. About one-fourth of a mile east of this ruin there is a small mound on the south side of the road around which there is considerable pottery. It probably represents a grave.

No. 162. This is the remains of a large ruin on the top of a large sand ridge, due south of Summit lake. The village was of adobe and apparently

was circular. A sunken depression, which was probably the central plaza, now remains in oval shape, forty feet across. Excavation might show this depression to be a large kiva. A great quantity of broken pottery marks the site and extends down the southeast slope of the ridge, likely marking a graveyard. Probably 300 people lived in this village.

No. 163. This is a small ruin on the north side of the road about one mile west of Summit lake. It had been made of adobe, all of which has been removed by time. Practically only broken pottery marks the site. Probably twenty people lived in this village.

No. 164. What appears to be the remains of a single-roomed house or a grave was seen northwest of the road, about a mile east of the pool west of Summit lake.

No. 165. One-fourth mile west of ruin No. 164 a similar mound and a small quantity of pottery was seen on the same side of the road.

No. 166. This ruin is on a sand-dune bluff abutting the east face of a Navajo sandstone cliff one-eighth mile southeast of the above pool, north of the road, three miles west of Summit lake. It is the ruin of a large village. It had been built of adobe, all of which has been removed by time. A great quantity of broken pottery is strewn over the site. Judging from the amount of shards, 125 or more people must have lived in this village. The pottery was the Kayenta type of ware.

No. 167. One hundred yards northeast of ruin No. 166 is a ruin or a graveyard—which, of course, excavation would determine. The pottery does not appear to be Kayenta ware in design. The design on one of the specimens has not been seen by the writer at any other ruin.

No. 168. This is a ruin on a sand knoll north of the road, three and one-half miles southwest of the above lake and one-half mile southwest of the above pool. Much broken pottery is being exposed by the shifting sand. No rock or other debris remains, the village evidently having been of adobe. Its size could not be estimated.

No. 169. On the west end of the same sand ridge, north of the road and north of a gulch, broken pottery shows for a considerable distance, 400 yards or more, and seems to represent two villages. The pottery of the western section is apparently cruder in make than that of the eastern division. The pottery of the eastern division is true Kayenta ware. Probably 100 people lived in each section represented by the pottery. The villages, or sections of the same village if they should prove to be parts of one village, were evidently constructed of adobe, all of which has been removed by air and water action.

No. 170. This is a small ruin, marked by a small mound and considerable broken pottery. It is on the west side of the road, about two miles northeast of Thief rock. Some rock was used in its construction. Probably not more than twenty-five people ever lived in it at one time.

No. 171. This is a ruin east of the road, about one and three-fourths miles east of Thief rock. Some stone was used in the construction. Scattering pottery is strewn about the site. Probably not more than thirty people ever lived in this village.

No. 172. One mile south of east of Thief rock, on the southeast side of the road, there is the mound of a rectangular village, forty-four paces in

length by twenty paces in width. The village has been made wholly of adobe. Considerable broken pottery marks the site. Probably 100 people lived in this village.

No. 173. This ruin is composed of a small mound of rock surrounded by fragments of broken pottery. It was of the circular village type. It is on the northwest side of the road, about one and one-fourth miles southeast of Thief rock.

No. 174. Just about south of Thief rock, in the center of the valley, a small point of Navajo sandstone is exposed, and extending northward from this there is a sand ridge one-fourth of a mile in length. On the rock point there is a ruin, represented mostly by broken pottery. Similar debris marks the east point of the sand ridge. Some stone also is strewn about each site. Seventy-five people probably lived in each of these villages. About half way between them there are indications of a graveyard having been there in the days of the villages.

THE BLACK MESA CLIFF RUIN.

No. 175. Until last year (1919) that cliff houses existed in the Black mesa district was scouted by all archæologists visiting the region, because of the friable and unstable nature of the rocks composing the mesa; but this year (1920) dispelled that delusion. While looking for pasture for horses early in the spring, Ben Wetherill (of the cliff-house-finding Wetherill family) and Vetress Wade discovered a ruin in this mesa, and in July following it was wholly excavated by the Arizona archæological party under Professor Cummings.

This cliff house is on the west side of a canyon in the Mesaverde formation, on the top of Black mesa, at the head of the trail that leads from the (Laguna) valley some eight miles south of east of Kayenta. It is high on a shelf under an overtowering arch. Also, some sixty feet above the main village there are some balcony (gallery) rooms situated on a narrow shelf.

The original village covered a space about 100 feet in length by 30 feet in width at the very widest. It was characterized by having rather large rooms—larger, as a rule, than the average cliff-house village seen by the writer. A block now containing two rooms with doors are still entirely intact. This block of rooms is built against the back wall and has square outer corners. Near it to the northward are three or four rooms nearly intact. A south room has a rectangular front. Against the southeast corner of this abuts a round, tower-like room of probably three feet in diameter, with a little three-cornered space between them, which has also been walled up and used as a room. Farther on to the northward are several more rooms about complete in wall structure, one being almost circular in outline; also, both at the north and south termini are partial foundation walls of rooms. Partial foundations of other rooms also show in the main room line along the wall. Fireplaces are also in evidence in most of the rooms.

In addition to the tier of rooms, along the front space to the very margin of the bench edge are two kivas in foundation with back walls three feet in height still standing. One of these shows the ventilator, both show the raised bench space along the walls for visitors' seats, and both show the characteristic floor plan, sipapu hole, etc., and one shows a loom loop space in the floor.

OTHER RUINS.

No. 176. This is a ruin on and about a white Dakota sandstone promontory on the south side of a flat about two miles northeast of Chilchinbito. An extensive cave also shows on the northeast face of the cliff. The ruin on top of the promontory and in the cave to the northward has been nearly all blown away or disintegrated. Some scattered rock and fragmentary pottery remain. East of the promontory an extensive village has been covered over with dune sand, so that only piles of rock debris show now and then. The cave should be excavated. Probably 130 people lived on this site. Their farm lands were those of the valley adjacent, and water supply was evidently furnished by damming the wash which now flows along the north base of the promontory. Another wash a half a mile distant to the north has permanent water the year round. Possibly water from this wash was also used.

No. 177. What appears to be the remains of a village is being exposed in a sand-dune area east of a low rock point about one-half a mile east of ruin No. 176. Its size could not be conjectured.

No. 178. In the flat about a mile northeast of ruin No. 177 is the remains of quite a village that was evidently erected of stone that was taken out of the adjacent wash. Piles of rock and scanty bits of pottery mark the site. A peculiar thing about this village site is that some Navajo has laid out a conjectured city in lines of rock over the site, giving pretended foundations of variously shaped rooms.

No. 179. This ruin is across the wash from the last ruin on what might be termed the first bench-slope of the adjacent mesa Much broken pottery is being exposed here by the shifting sand. No idea could be had as to the size of the village.

No. 180. The fragmentary remains of a small ruin shows on the north bank of Laguna creek about due north of Church Rock. A few rock and much broken pottery now mark the site.

No. 181. On the south side of the creek, about one-half mile west of ruin 180, there is considerable scattered pottery, likely the debris of a small village.

SEGI-OT-SOSIE RUINS, SNAKE HOUSE AND ADJACENT RUINS.

SEGI-OT-SOSIE SECTION.

Segi-ot-Sosie (slim, narrow) canyon and wash run northward through the northwest part of Tyende mesa some ten miles northwest of Kayenta. On reaching the flats north of the mesa, the wash continues on northward to the San Juan. The canyon is narrow, often only a few hundred yards wide with walls 500 to 700 feet in height. After extending southward from the canyon mouth for more than a mile and a half the canyon forks, one branch (West canyon) taking a northwesterly course, the other continuing on in a southerly direction. The South canyon has side pockets in it, one large one extending eastward about one-half mile above where West canyon leaves the main canyon. The writer will call this canyon East canyon. West canyon also forks after extending a half a mile or so, each fork becoming very narrow, though to where it forks it is itself as wide as the main canyon below the forks.

In these canyons there is an abundance of clear water running on a level with the canyon floor, also big trees and grass. Just above the forks of the main stream in South canyon there are numerous bubbling springs and a fine Navajo peach orchard, in which alfalfa is growing. At the mouth of the main canyon a Navajo is irrigating three acres of alfalfa, when there is water enough to irrigate a section of land. Moreover, in the long ago 1,000 people lived in this canyon and had a good living, where now within its high walls and in the tributary country thirty-five Navajos starve.

Along the walls of this canyon there are caves, overhanging cliffs and pockets. All of these have at times been house sites for the abode of aboriginal man of the cliff-dwelling, village type. Villages were also erected in the open now and then. Those examined by the writer are given below. Others could not be visited for lack of time.

No. 182. (See plan, plate 3.) This is a ruin along the east wall of West canyon. The ruin is a cliff house which was once quite large. Two rooms are still practically intact and many walls are practically entire Others can be traced. Probably 100 or more people lived in this village. Rock and adobe were both used in the construction of the houses This ruin has been examined by Dean Cummings, and last July (1920) Professor Guernsey did excavation work in this ruin, securing, among other things, a string of shell beads forty-two feet in length So far as the writer knows, there is no published work on this ruin.

No 183. This is a large ruin under a cliff up the same small canyon northwest of ruin No 182. It was examined by Dean Cummings and party in 1917 and much valuable material taken from it

No 184. This is the remains of a ruin in the valley in the open, in the same little canyon, one-eighth of a mile southeast of ruin No. 183. Only broken pottery now marks the site.

No. 185. This is a ruin in the pocket of East canyon. It was seen by the writer only at a distance. The writer has been advised that Mr. Guernsey found much valuable material in this pocket last July.

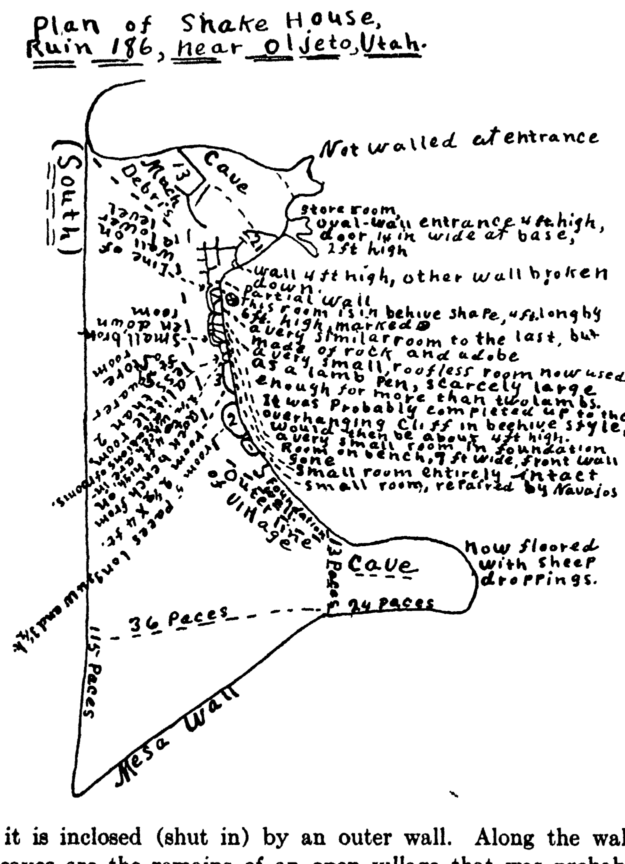
THE SNAKE-HOUSE SERIES OF RUINS.

About two miles west of Segi-ot-Sosie canyon a parallel canyon runs northward between Tyende mesa and Skelton mesa. Also, after coming out in the flat beyond the former mesa, the wash from this canyon skirts the latter mesa for several miles till it joins Segi-ot-Sosie wash, the combined wash finally reaching the San Juan, as we have seen In this area the east front of Skeleton mesa is pitched eastward at a high angle, as a part of the broken Comb ridge system, showing quite a rugged character. A long line of sandstone cliffs and points sloping eastward, jagged and toothed, with intervening valleys, canyons and *rincons,* are the outstanding, conspicuous features. In the pockets and side canyons and in the protected places in the open there are ruins of villages and storage bins. Some of these have been seen and partially examined; others have not. Below are those known to the writer.

No. 186. (Snake House; see plan, plate 5.) This ruin is about five miles southwest of Oljeto and about three miles northwest of the mouth of Segi-ot-Sosie canyon. It is a large village in an isolated, jagged valley along the southeast front of a small detached mesa and in two extensive caves in the

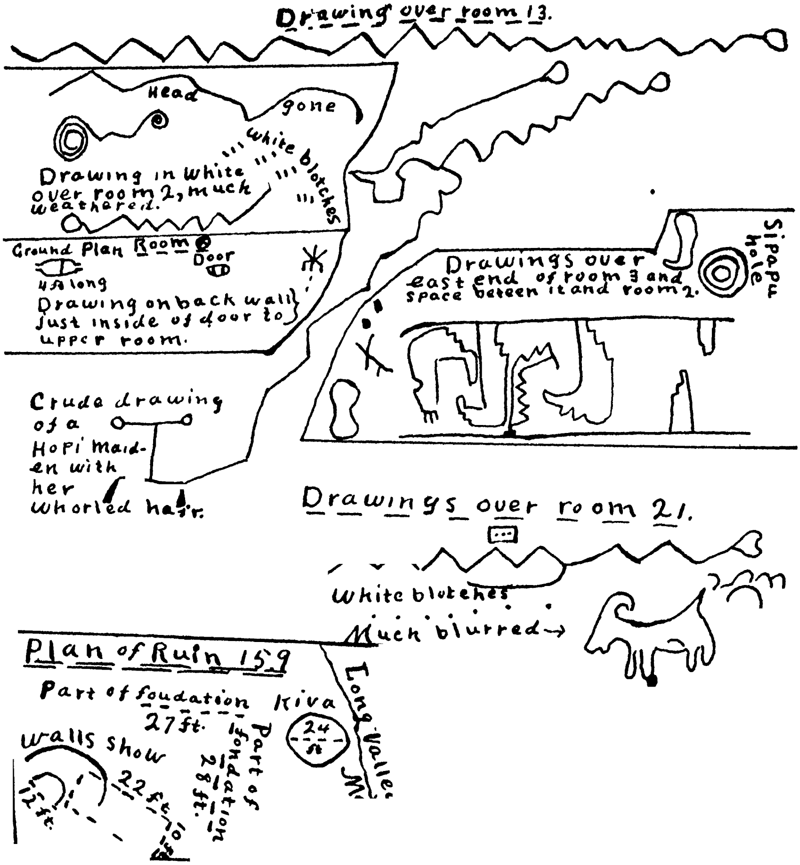
same, one at each end of the outer ruin. The east cave is about 100 feet deep back into the cliff, and probably 25 feet wide. It seems to have been a large council hall. It is smoked from end to end and has much pottery debris on its floors. No signs of rooms now remain. The cave at the west side (end) is 40 feet wide at the entrance, runs back 40 feet, and has two sets of additional rooms running back from it into the cliff. The north room is walled in now, and was used as a bin. Part of the wall that inclosed the south room also shows. Parts of walls also show in the main cave room. In

PLATE V.



addition it is inclosed (shut in) by an outer wall. Along the wall between the two caves are the remains of an open village that was probably 25 feet wide. Many rooms are still intact, with roofs still on them. Some are flat-roofed; some are built in half-beehive style against the wall. All are small and all have very small doors. Above the west end of the outer village is a large drawing of a huge snake 40 feet in length in zigzag, with 21 joints. Its head is two-thirds as big as a plate and in that shape. The whole drawing is white. Several other snakes are also drawn on the walls. The snake clan of a tribe evidently lived here, probably a snake clan of the Hopis. The ruin received its name from the snake drawings over it.

PLATE VI.



Drawings about snake house

The Cummings party examined this ruin some years ago, and Professor Cummings figures a picture of this ruin in his report and also makes mention of the ruin.[8]

Probably 100 people lived in this village.

No. 187. This is a cave ruin in an isolated rock ledge about a mile south of Snake House. It was not seen by the writer, and so far has been seen only by Missionary Leigh Segar, of the white race. An Indian has found some nice pottery in this ruin, among which was a large corrugated storage jar filled with pumpkin seeds. Not knowing the value of these seeds, the Indian let the mice eat them. The Indian gave the missionary the jars he found, and they are now in the state collection at the university at Tucson.

No. 188. (See plan, plate 4.) A cliff-arch ruin two miles south of Snake House, under a south-facing arch of the east face of Skelton mesa, was once a considerable village. It has been excavated by Navajos. Last spring (1920) an Indian dug up a large corrugated jar from it, which he much broke in re-

8. Cummings, 1910.

moving it. The jar had yucca harness about it, and also had a flat rock placed over its top when found. A much larger decorated jar was broken in getting it out. Pumpkin seeds, pumpkin vines, sandals and various other things were dug up and left by the Navajos. The writer picked up all that was left when he visited the ruin, August 29 of the same year, and they are now in his collection These include sandals, prayer sticks, rainbow-hoop prayer sticks, and feathers, besides the pumpkin vines.

MONUMENT VALLEY AND ITS RUINS.

This region lies between El Capitan and The Monument. The washes all head in the El Capitan plateau, and after running a northern course of a few miles they all come out on the Monument flats, either singly or as combined washes, where they join in a master wash in a sand-dune-swept desert area There are no permanent springs in the region, but pockets in the rocks usually hold water the year round, with the exception of exceptionally dry years. The semidesert vegetation is composed of cedar and pinyon scrub oak; and box elder heads some of the canyons and also grows in a few favorable spots. Narrow-leafed yucca, greasewood, sage and cactus are the small plants most seen. Navajos with their sheep and dirt (hogan) houses are seen now and then, while at intervals a corn patch is seen in some favored spot.

In this region there are no large ruins. Many of the cliff-house inclosures were bins and not dwelling places About these there are usually but scanty or no pottery fragments and little or no rubbish. Moreover, these rooms are usually not smoked; neither do they show any other signs of having been used as dwellings. Other ruins seem to have been hunting or summer lodges. Several others, though small, seem to have been permanently inhabited.

The smallness of the ruins that show any signs of having been used as dwellings at all, and the fewness of them in this extensive area, would seem to indicate that the region then would not support a larger population than now, provided the people had only the same wants. This again verifies the claim that the climate in the region of this valley was the same in the days of the villages as it is now, and that it was the same in the whole Kayenta region then as at the present time.

This region was visited by Kidder and Guernsey in 1914 and several ruins were examined. These were also visited by the writer, and in the report they will be given only a short description, or merely mentioned, the readers being referred to the report of the above authors for a complete account of their findings [4]

No. 189. Soon after entering the canyon on the direct road northward from El Capitan, five miles north of that volcanic monolith, there are ruins on a cliff bench along the southeast wall of the canyon. One large room has been closed in. It had been almost oval in shape. The wall showed the door in the center; it had been small. The upper east half of the wall has fallen. On the same ledge to the southwestward were two other small, old-fashioned bee-hive-shaped ruins (cut in half) set against the wall. Their walls were intact. Near them to the southwestward, above the same ledge under the same over-hanging cliff, holes had been wholly or in part chiseled in the rock and walls

4. Loc. cit., pp. 15-45.

placed across them. One of these small rooms was placed above another of like dimensions. These were probably storage rooms. Probably there are more ruins in the vicinity, but time would not permit looking for them.

No. 190. On the opposite side of the canyon, about a mile north of ruin No. 189, are several cave holes in the sandstone wall of the canyon. All no doubt were used as caches or dwellings in the old times, but now the walls and debris in many instances have been removed by time. Others still have the front walls more or less intact. One of these is ruin No. 190, here given. It is sixteen feet long by three and one-half feet high at the mouth, and tapers back. Its mouth is five feet wide by four and three-fourths feet high, rounding slightly at the top. The door is eighteen by twenty-four and one-half inches. A rear cross wall shows ten feet from the mouth. Much guano covers the floor. Near

Two granary rooms in Monument valley canyon. Ruin No. 191½.

it, on the same level, is part of a wall to a similar cave room. These ruins are figured on plate 2 of Kidder and Guernsey's report and are designated as granaries, which they undoubtedly were.

No. 191. This is a similar cave ruin, 105 yards north of ruin No. 190, 40 feet higher up on the ledge.

No. 191½. This is a double ruin on the west side of the canyon, near its mouth. This double ruin is figured at the bottom of plate 2 of Kidder and Guernsey's report. It evidently was a granary. See photo herewith by the writer.

No. 192. (Ruin No. 1 of Kidder and Guernsey.) Out in the flat northwest of the mouth of the canyon there is an isolated hummock mesa of sandrock. On the southeast side of the hummock, in a recess about 20 feet up, there is a cliff house. For a complete description of this ruin see Kidder and Guernsey's report, pages 16 to 19, to which the reader is referred. A mound ruin of a village also shows near this cliff cave.

No. 193. This ruin is about a mile west of the last ruin in another (Sayodneechee) canyon. It lies in a cave seventy feet across the mouth. To the writer, who was alone, the place was inaccessible, as to enter the cave one must climb over a fifty-foot sloping rock and then climb straight up twenty or more feet. This ruin is ruin No. 2 of Kidder and Guernsey's report (pp. 19-24), to which the reader is referred.

No. 194. This is a mound one-half mile below ruin No. 193 in an eastern side canyon. It is irregularly circular, one hundred and three feet in diameter and four feet high at the center. It is probably the ruin of a circular village of adobe or wickerwork construction. For a further account of this village and the cliff house near it, next described, see Kidder and Guernsey's report (pp. 24-27).

No. 195. Near the above mound is a much-smoked one-roomed house in a little cave. It had evidently been used as a dwelling.

No. 196. (A watchtower.) Opposite ruin No. 193 there are three buttes. The southernmost of the three has what appears to be the remains of an ancient watchtower. For a further description of it, see Kidder and Guernsey's report (pp. 26-27).

No. 197. Nearly opposite ruin No. 193, on the same side of the canyon as the "watchtower," there is a burial cave. It was hurriedly visited. In this cave four burial cists show excavation, in which Kidder and Guernsey exhumed thirty-two skeletons. For a description of this cave and its cists the reader is referred to the report above mentioned (pp. 27-32).

No. 198. About a mile a little south of east from ruin No. 192, in an east-entering side canyon, is a ruin in an enormous cave some 70 feet above the valley, with the canyon walls rising absolutely sheer to a height of 200 feet above it. It is inaccessible for a lone man, as 30 feet of the approach is perpendicular. This ruin is ruin No. 3, or Fire Stick House, of Kidder and Guernsey, to whose work the reader is referred (pp. 32-36). In their report they state: "We found it to consist of a single line of ten living rooms with a continuous front wall, but flush with the edge of the cliff. The back part of the cave slants up too steeply to have been available for buildings. There is no kiva, nor could we find any trace of one in the valley below."

No. 199. This is ruin No. 4, or Pictograph Cave, of Kidder and Guernsey. The most interesting feature of this cave is its pictographs, hand prints, human figures with peculiar headdresses, etc. The ruin consists of a little group of rooms built against the cliff about 587 yards below ruin No. 198. They are partly sheltered from storms by a great shoulder rock and partly overhung by a 200-foot precipice. The buildings were in a very poor state of preservation. For a more detailed account of this ruin see the above-mentioned report (pp. 36-40).

No. 200. This is a cliff cave on the east side of the mouth of the (Monument) canyon, 400 yards west of a water hole on the north side of an east-leading side canyon. The cave is 40 feet across the face, 12 feet deep and 20 feet high. It was once used as a cliff-house site. The debris is now wholly gone, as it has been swept for ages by the southwest wind.

No. 201. This is a rainbow-arch cave around a corner point of rock on the north side of another east-leading side canyon, about one-eighth of a mile

southeast of ruin No. 200. It has 100 feet front, facing the south. It is 100 feet high to the top of the arch from the valley. The arch is 40 feet above the base of the cave. The bridge part is 12 feet wide. A cliff house has been built under each approach, but the east one is now wholly gone. Under the west abutment there are two rooms. One is wholly intact; the other has only the foundation left. Each was built in the old-style, semibeehive shape against the wall, like a half cone set against the wall. The north room, which is only in foundation, is filled with bat and rat guano. It was about 10 feet across. The south room is about 16 feet across the semibase line, 7 feet deep and 6½ feet high. The door was on the north face. It is about 18 by 24 inches. The sill above the door was of wood and is still in place. The walls were of rock and adobe plaster. The mortar was well laid and is quite hard. The village was certainly in an ideal place.

Snake House, near Oljeto, Utah.

No. 202. A similar natural-bridge cliff cave to ruin No. 201 is situated around a point of rock on the same side canyon, about 120 feet east of that ruin, but is considerable larger. The debris is now wholly removed, but the space beneath the bridge once evidently contained rooms.

One hundred twenty feet above this space bridge-cliff cave, a little to the rear, is a long arched-over, inaccessible cave. From the nearest point to it that could be reached no debris or rooms could be seen in it. Its axis lays east and west and it is open to the south.

No. 203. Debris on the north side of the same canyon, 300 yards northeast of ruin No. 202, now shows, but the size of the original village cannot now be determined.

No. 204. This is a village in the open, across the canyon south from ruin No. 201. It resembles the open ruin near ruins Nos. 192 and 194, except that some stone shows in the foundation as well as room walls. Part of the foundation walls of three rooms show; also some pottery fragments are scattered

about the site. Parts of a cist two feet square, surrounded by rocks on edge, also still show. The village was of the circular type and was evidently very small.[5]

CONCLUSION.

In this region there are many circular villages with peripheral compartments, also some D-shaped villages with the straight line on the south side. These are very similar to the circular and D-shaped ruins described by Doctor Fewkes.[6] "Great houses" do not exist in the region in standing position, unless Long House (ruin A) is one; but there are indications in foundations that such houses did exist. Moreover, had the rock of which many of the villages and buildings were made been as durable as the much harder rock of which the prehistoric villages, castles and towers of southwestern Colorado were constructed, the region undoubtedly would be studded with village

Ruin 102, in Kaykohte canyon

masses, great towers, etc., to-day, the same as that region. From descriptions the writer has seen he would judge that the Colorado ruins were built of limestone or very hard sandstone; the Tuba-Kayenta ruins were erected of friable, crumbly, soft sandstone, mostly of the Navajo formation of rock, when not made wholly of adobe or of latticework and plaster. The only exception the writer has seen is that of Donahotso Keetseel (ruin No. 133) of this report. It was constructed of very hard limestone, and to-day it makes a considerable pile, with some rooms still intact, though the village is exposed in the open. This also brings up another point: Were most of the villages which are now reduced to a few inches of debris in depth, including fragmentary pottery, made of soft sandstone, and has the time since they were evacuated been so great that the building blocks have entirely disinte-

5. At times village sites mentioned in this report might have been segments of a scattered village, like the scattered segments of the Jemez village of the present day, but as there is no evidence at this late date that they positively were, each mound, etc., has been considered as a unit in itself, unless otherwise stated.

6. Loc. cit., pp. 31-36.

grated and been removed by wind and water? It would seem that such is the case, but a great deal more study will have to be given to the ruins of the region before such a conclusion can be verified.

As a concluding sentence, the writer wishes to add that either an immense people lived here at one time or a small population a great number of years. The data seems to point to the latter conclusion.

Some Notes on the Lummi-Nooksack Indians, Washington.

ALBERT B REAGAN

In 1904 I was placed in charge of the Lummi reservation in the state of Washington. Below are some of the observations I made while in charge of that reservation and its Indians.

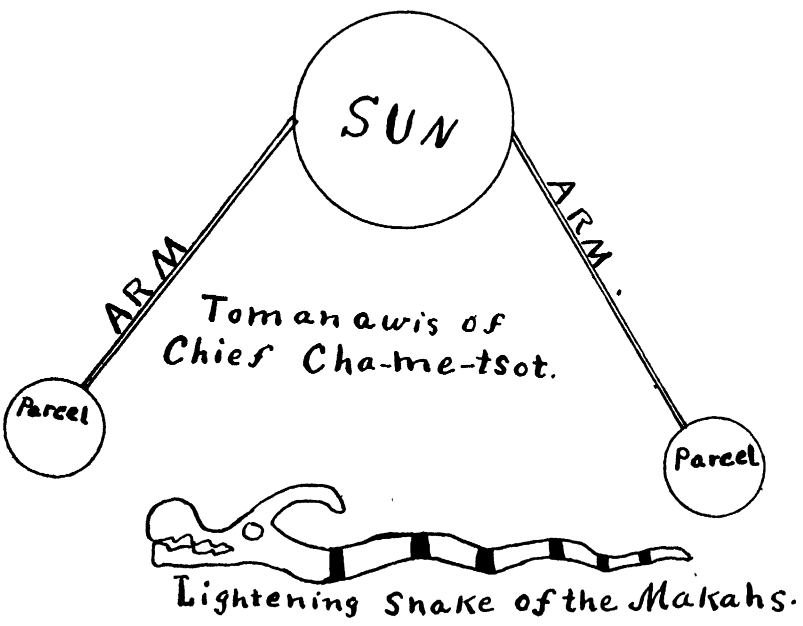
The Lummi Indians occupy the Lummi peninsula, facing Georgian bay and Hale's pass, about twenty miles south of the British Columbia line, just across Bellingham bay from the city of Bellingham, Wash The Lummis are now mostly half-breeds. They number about 375. The full-bloods are nearly all old people. These are much diseased. Practically all of them have the sore-eye disease called trachoma (?), and many of them have it in such a virulent stage that they have become blind. These Indians are fishing Indians, but also farm on their allotments. Their principal fishing season is August and September. The fish caught are salmon and halibut. These they dry for themselves or sell to the canneries They now dry their fish in a fish house, but in the old times they would cut the fish into strips or halves and place same on a puncheon slab and prop this up before the fire. In the old times they made flour from fern roots. They also made salmon egg cheese. They put salmon eggs in a hair-seal pouch, and this they hung up in their smokehouse to dry and be smoked by the smokehouse fires till cured to the Indians' taste. A white man probably would not have relished it.

The tribe as known to-day is made up of the Lummi, Snohomish, Nooksack and British Columbia Indians. They belong to the Salishan linguistic stock and now all speak the Lummi branch of that language The Chinook jargon is also used extensively. The young people all speak English well.

Besides being fishermen, each Indian has an allotment on the reservation. On these they are now doing quite extensive farming, which is well done, and in 1904 their houses were often better than those of their white neighbors, though sometimes not kept quite so neat and clean. In fact, they have advanced nearly to our standard, many even taking daily papers.

In the old times these Indians practiced all the ceremonies known to their linguistic group. They waged war for the sole purpose of capturing slaves. Moreover, they had grades or castes, in a sense, among them. There were chieftain stock, common people, and slaves. Furthermore, the results of the hunting and fishing trips were portioned out among the participants by the leading chief according to the standing of each person. For instance, the chief always got the choice part of the whale. This consisted of the saddle and other special parts. The base people received the red meat, but little or no blubber. These people flattened their babies' foreheads so that a modern hat fits them better crosswise than the way a white man would wear it. They had puberty customs and mortuary dances, and had many dance lodges and secret

orders. They believed in the supreme human power of the medicine man, and slashed themselves with knives and thrust their arms through with elk bones and arrows and drank their own blood in their frenzied medicine dances and medicine ceremonies. They had give-away (potlatch) feasts, at which the man who gave the most things away and gave away all he had was the rich man, the "big" man of the tribe. They also wore token effigies suspended from their neck beads, and carved or painted their special visions or dreams (called in Chinook, tomanawis) in conspicuous places in their "plank" houses, usually on totem poles, as a mark of good luck or a guide in their lives.



These people also had large give-away feast (potlatch) halls, large enough to accommodate from 500 to 700 people. These halls were also dance-feast halls and lodge ceremony rooms. Once when at the "portage" on their reservation I visited the ruins of one of these halls. A row of column posts marked the site. The posts were about two feet in diameter. Nothing else of the great hall was left but a ridge of earth that marked the outer boundaries of the building when intact. On examining the columns I found that each post had a carving on it facing the inside of the hall, and that the carvings were similar. I give herewith a reproduction of these drawings. I also inquired among the Indians for an explanation of this totem *tomanawis*, and the following was given me by William McClusky, the Indian judge of the reservation:

"Chief Cha-we-tsot once owned the *potlatch* house at the portage. The drawings on the totem posts there are his *tomanawis*. The sun, carrying a parcel of valuable in each hand, came to him in a dream and said: 'Your storehouses (trunks) will always be full. You will therefore give two more feasts than the average chief. Custom had established the rule that the ordinary chief should give three feasts in a lifetime; that is, feasts of the

potlatch type. So Chief Cha-we-tsot built the *potlatch* house and carved his *tomanawis* on its totem posts. He then gave five feasts, two more than the average, as the sun in the vision had commanded him."

Further notes obtained on these Indians are as follows:

SOCIOLOGY.

The "caste" system has been mentioned. These people were divided into the usual threefold divisions of chieftain stock, notables, and base people (the latter often being the descendants of slaves), as is usually found among the coast Indians. The office of the chief was hereditary, though the people held the power to depose an undesirable, undeserving chief and elect another in his place. The chief was also a sort of father and high priest to his tribe. Now that the Lummi are Catholics, this person leads the services in the church on Sundays when the regular priest cannot be present. At these times the Indians pass around in the church from left to right, while they sing and pray a few minutes in Indian before each of the passion pictures, the altar, and the images of Christ and the Virgin Mary. Then they quietly leave the church, usually to partake of a picnic dinner. A deposed chief would usually be superseded by a relative, so that the chieftaincy generally remained in the caste or family of the chief. Neglect of the material welfare of the tribe was thought the greatest offense that any chief could commit. A vote of the chief men and elders of the tribe would vote a chief out for cause and appoint his successor.

The tribe originally had several secret societies, each of which had its own peculiar dance. They also had fish-season dances and a feast dance of the first fruits.

Some of the Indians had more than one wife, the number being governed, in part at least, by his ability to support them.

The chieftain stock of this tribe also had slaves. These were captives taken in warfare or in raids on distant settlements.

HOUSES AND HOUSEHOLD ARTICLES.

I was told that the houses of the Lummi in the old times were the long ceremonial slab houses built in rectangular order like their fish houses at Fish Point are now built, except that the fish houses are made of modern material. The communal houses were semiflat roofed, the roofing being of puncheon planks and sloping one way. In the old times the Indians lived in these communal houses for protection.

The Lummi made blankets from split roots of young cedar and from young spruce roots. They also made ropes from twisted sinew and from twisted spruce roots. They had wooden spoons, ladles, platters and dishes, all usually of large size. I also saw several horn spoons. I helped collect curios for the Commercial Club at Everett, Wash., used in the exhibit at Portland, Ore., for the Lewis and Clark exposition. Among the curios collected was a large cedar trough eight or ten feet long and three feet wide. This was used in the preparation of soups and stews, usually at feast times. The eatables were prepared for cooking and placed in the trough, and then heated stones were thrown into it to effect the cooking process. Mats were then placed over the trough to keep the steam in and to hurry the cooking. Other curios were a very large wooden ladle and a maple-wood dish three feet long by one and one-half feet wide.

DRESS.

In the old times the dress of the men consisted of shirt and blanket made of buckskin or pounded inner bark shreds of the cedar tree. A deerskin or bearskin overblanket was also worn when fishing in wet weather. Robes were made of woven dog's hair and from prepared bark or flags. Blankets were woven from the down of birds or strips of rabbit skin, the warp being made of strips of shredded cedar bark A conical hat woven from spruce roots was also worn. This hat was woven so compactly as to exclude the water. The dress of the women in the old times was a subblanket and a cincture of fringed bark reaching from the waist to the knees. The Lummi belle wore ear pendants and a robelike shawl of wovenwork and ocean shells and painted her face and the parting of her hair with whale oil and mineral paint. Some of the Indians wore moccasins. Turbanlike cedar headwear was occasionally worn.

THE MEDICINE FRATERNITY.

The medicine man was a powerful personage, especially the witch doctor (*tomanawis* man, to use the Chinook jargon) They had three kinds of doctors, but the witch kind is the only one I learned much about. The witch type consists of men and women, and these were often the leading persons in the secret societies. They would "cure or kill" people with their witch power, as they wished. Hence their good will was sought lest they should do injury with their *tomanawis*. These were the doctors called when a person was "spirit sick." Most sickness among the coast Indians is believed to be caused by one's spirit temporarily leaving the body, and should it not be brought back the person will die The shamanistic medicine man had the power to restore this lost soul, provided he could overtake it in spirit before it crossed a certain river in the land of the dead. Sickness might also be caused by a magic spell or by the bad witch power of some medicine man. This also the good medicine man could relieve in the same manner as ordinary sickness.

One of the old men told me about his journey into the land of the dead after a fleeing soul. He said he went into a trance state, and in spirit followed the soul on its journey to the "land after breath is left the body." "The spirit of a person," he said, "looked just like a person, only very small." The spirit he was after was in the possession of the bad spirit of a very bad medicine man. The aged sire continued

"This spirit was running with the sick one's spirit The road we were on was crooked and stony. As we ran I noticed that the trees along the wayside were mere bushes. The salmonberry bushes (*Rubus spectabilis*) were only about six inches high and the berries were so small I could hardly see them. The salal (*Gaultheria*), thimbleberry (*Rubus odoratus*) and the crowberries were also very small. The strawberries were very tiny things and the ferns of the prairie were only two fingers high. People were gathering the berries and fern roots. You know, people make bread from fern roots. The people I saw gathering the berries were not a finger-length high, and their talking was like the noise of a grasshopper or cricket. As I followed the fleeing soul farther I came to a little stream. There the people were fishing. They had the stockade fish trap in operation. They were catching it full of what they called fish; but I examined the so-called fish and found them to be knots of wood. I also passed by the ocean beach in that land of the dead, and as I came to it I heard the people shouting. 'A whale! a whale! a whale has been killed and is being towed ashore!' Being an old whale hunter myself, I paused

a moment to see their whale; and lo! their so-called whale was a large fir log, but the people were cutting it up and carrying off the pieces. But on I ran. I came to the fatal river before me. I tried to sieze the soul of my patient; but the evil *tomanawis* witch leaped with it across the turbulent waters and a piteous groan told me I was too late. When I came out of the trance the patient was dead.

"At another time I passed over the river of the dead, and there I saw the reverse of what was on the first side of the river. The people were all large, strong and happy. The trees were all large and the berries were all larger than I have ever seen here. All the bushes were heavily loaded with fruit. There was also plenty of game and fern-root bread, and there were feasts and dances every day in that happy land. At this time I overtook a fleeing soul and brought it back, and by a pouring, stroking process I put it back in its body form again and the person is still living.

"At the times we are going after fleeing souls to restore them to sick persons, we go apart by ourselves, crouch down and cover ourselves with a mat and permit ourselves to go into the trance state Our souls will then leave our bodies and go in search of those of the sick ones."

The medicine men were doers of tricks and mysterious performances. Some could handle fire, dance upon hot stones and place hot coals in their mouths, apparently without being burned. Some of them could also drink five gallons of whale oil at one time, or otherwise mysteriously dispose of it. Tricks and slight-of-hand performances as well as hypnotism were used to keep the people under their power.

Hypnotic contests between medicine men were ordinary scenes at the secret lodge dances. One medicine man would challenge another to exhibit his "medicine" powers; and the one who would outdo—that is, hypnotize—the other would receive the applause of the spectators, and henceforth the medical practice of that community or village would be his. When the white doctors came in contact with the Indians the medicine men would also challenge them to exhibit their powers.[1]

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1 I once met an old doctor who had doctor d the Lummi in the early days He said that once when he was called to an Indian house to wait on a sick Indian he noticed that the house was full of Indians, and among them was the leading shaman of the tribe. No sooner had he entered the house than the old medicine man arose and accosted him "Could the white medicine man give an example of his power? ' He then began a tirade of abuse against the physician and announced that the proof of the soup was in the eating, and that they must fight in doctor *tomanawis* style to see which doctor had the patient

"I saw at once," said the white physician," that I was in for big trouble unless I used strategy. But I had one big advantage I kn w the Indian's *tomanawis* methods, but he did not know how the white man philosophized At once I gathered all the Indians around me and made a speech agreeing that the Indian doctor and I should each use his *tomanawis* on the other and the one who possessed the greater power should doctor the sick man and should not be molested by the other

"The Indians understood the proposition and seemed pleased and grunted their satisfaction, with the exception of the Indian doctor I saw at once that he was scared; he was afraid my *tomanawis* would kill him To reassure the medicine man, who was a big, strapping Indian, I offered to let him use his *tomanawis* first With the Indians gathered around us in a big circle, I wrapped my coat and overcoat closely around me, and, muffling my head, lay down and told the medicine man to go ahead He at once proceeded, going through incantations and hokus-pokus lingo over me After I had lain there a long while I sat up and told the Indians that the *tomanawis* of evil with which the Indian had tried to kill me had never bothered me in the least.

"I then demanded that the Indian take my *tomanawis*. The fellow was well-nigh scared to death, but I insisted, and the Indians were with me I fixed up the worst dose you ever heard of, making about a spoonful of an emetic, a physic and an anodyne. He backed off and tried to avoid taking the dose, but I made him take it For hours he was the sickest man I ever heard of. The Indians expected him to die, but I told them that my *tomanawis* would make him very sick, but that he would be well by the next sunrise. Then I doctored the sick man who had sent for me.

"The next day the medicine man recovered according to my prediction, and in a few days the patient also convalesced. The medicine man had found a *tomanawis* stronger than his own; and his reputation was thenceforth ruined among the Indians."

BIRTH CEREMONIES.

In delivering children the Indian women require but little assistance, and they are seldom confined to their houses more than a couple of hours, or possibly a day, after delivery The birth of twins in the old times was supposed to have some evil portent, and often the children were put out of the way.[2]

In the old times it was the desire of the parents to have their newborn get the blessings of the "powers." It was therefore the desire that the chief medicine people of the mother's totem brotherhood be present at the time of the birth or soon afterwards to perform and dance over the child and pray over it, to secure for it the protection of all the good spirits. A person thus performed over was made a person of social rank among the notabilities of the tribe. The ceremonies closed with an elaborate feast, and is still held as a birth ceremony among these peoples. This feast was held as soon as the mother was well enough to help prepare it and to attend the ceremonies At this feast-dance the child's ears were pierced and pads and bands were placed on its forehead to give it the flathead shape The ears were pierced by means of pointed pieces of pitch pine, the piercing pieces were left in the hole to prevent it from closing This feast was closed by a give-away service (*potlatch*), at which the parents often gave away all the property they possessed as "pay" for the people attending and taking part in the ceremonies.

It might be added here that as the child grew up he was admitted into each of the different orders (secret societies) of the tribe in an elaborate feast ceremony as fast as his parents could accumulate wealth to furnish the *potlatch.*

PUBERTY CUSTOMS.

While I was in charge of the Lummi reservation one of the school girls did not come to school I asked the police to get her. He then told me the girl had had her first menses and was looking for her "guiding" spirit, and that she would be back in school in a few days. He then related to me some of the things about their puberty customs and ceremonies. He said that when the puberty period came to a boy or girl he or she went off alone to some secluded place for four or more days and fasted and prayed and exercised their bodies till in a dream vision their "guiding" spirit appeared unto them. At this time the boys also bathed in the ocean water in the early morning, and then just as the sun was rising they dried themselves by rubbing their bodies with the brush of a certain tree, always keeping the cut-off end of the brush pointing toward the rising sun. At night they must also go to the graveyard and tie old bones and human skulls together and drag same around after them by the hour to make themselves brave

Besides being in seclusion, the girl was compelled to abstain from food of any kind the first two days of her staying apart by herself. Then she might eat a little dried salmon, but no hot or fresh foods—fresh meats, roots, or sprouts (greens).

The girl in question spent her spare moments knitting while she was in seclusion. On the fourth day she painted her face, and in company with several medicine people walked about the village. Later in the day these

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2. A case is reported in which an Indian woman gave birth to twins on a channel boat, whereupon she immediately threw them overboard.

same medicine people danced around her and went through various contortmg ceremonies, each holding a different kind of fish in hand. Then when her period of seclusion was over they took her to a small stream of water that emptied into the swamp and had her bathe and undergo ceremonial cleansing. I asked my informant why it was necessary to go so far to the little stream when the big Nooksack ran so close. To this he replied that the Nooksack was a salmon stream, and should a woman bathe in a salmon stream at such a time the fish would shun the stream thereafter. The puberty period of seclusion of both boys and girls was followed by a dance and give-away feast, and thereafter the girl was considered marriageable.

MYTHOLOGY—MT. BAKER.

I obtained but one myth from these people. One day it thundered, the noise coming from a cumulus cloud southeast of us, toward the mountains from Lummi. The Indian with whom I was talking at the time said, "Do you hear the thunderbird?" I did not understand what he meant and asked him to tell me about the thunderbird and the thunder noise we had heard He said

"You see, it hardly ever thunders here; but yonder in the mountains it quite often thunders. The thunder is caused by a great bird. You have seen the fish hawk catch a fish Well, the thunderbird is many hundreds of times larger than a fish hawk It is so large that it can carry a large whale in its talons from the ocean to its nest. The feathers of its wing tips are as long as a canoe paddle This huge bird has its home yonder on Mt Baker, where you see the clouds piling up now. Whenever this bird comes from its nest and flies about the mountain top it thunders and lightnings, and even when it is disturbed in its nest it makes the thunder noise by its moving about even there. Furthermore, when greatly disturbed or when in search of food it flies far from its mountain home, far out over this place. The flapping of its wings at these times causes the distressful, destructive winds and the furious storms The lightning is caused by the quick opening and shutting of its powerfully bright, snappy eyes and the thunder noise by the rapid flapping of its monstrous wings[3]

"This bird likes fire, and if it cannot find any it will send a streak of flame from its angry eye and strike something and start a fire. It is dangerous at these times, for the bolt of fire thus hurled will kill anything it strikes. To appease the wrath of the enraged bird we make a fire and the most possible amount of smoke in our houses as soon as we hear the thunder noise in the clouds."

ARCHÆOLOGICAL NOTES.

The archæological remains found here are middens and mounds. The middens are of two classes—ancient and modern.

The Lummi peninsula was an island until recent times. The delta deposits of the Nooksack and Red or Lummi rivers were filled in against this island (of glacial material) by these rivers till it is now mainland. These deposits are more than thirty feet thick, as is shown by the finding of logs at a depth of thirty feet at several places in the delta area. While this delta area was still covered with ocean water, Indians lived at several places on the glacial island adjacent to this now filled-in section. These Indians were fishing Indians, the same as the Indians now occupying the region. They lived on what was once the water front, as they were a canoe-using people and consequently

3. The Makah Indians have the same myth, except that the lightning is caused by lightning snakes darting out from under the great bird's breast at intervals as it flies through the sky.

would not have their villages far from water. They were clam-eating Indians, and clam and mussel shells constitute the principal middens marking their village sites. One midden heap occurs about one and one-half miles northwest of Fish Point; another on the west side of the peninsula, on the west side of what was then an island, about due west of the last-named midden heap; another occupies about the north point of the then island. These middens are covered over with from a foot to three feet of sand and loam, and over them were growing trees that must have been 500 years old when first seen by white men. This would make the middens quite ancient, if the rate of delta deposit was as slow formerly as now—probably 1,500 years old. Similar middens were found about a mile south of Fish point, also on the southwestern point of the peninsula, and at another point on the east coast line about half way between the portage and Fish Point.

A group of middens were also observed on the north shore contact line of the glacial deposit area north of Hale's pass, but these were not covered with earth and had the appearance of having been made in the last 150 years.

The village site of 1880 was mostly destroyed by encroachments of the Nooksack river, but the islands (practically the only remaining part of the village) shows three occupations, but none so old as the middens described above. There is a series of shells covered by about two feet of earth. On top of these is another series of middens, probably a foot in thickness. These are characteristic, because the top layer contains Hudson bay trade beads. The surface middens are those of the village abandoned in 1880.

More ancient middens were found farther inland in the middle Nooksack valley and at the foot of the Sumas mountains and on northeastward into Canadian territory. Some of the midden remains are very large. They are now twenty miles inland and must have been thrown from the Indian kitchen when Georgian bay had its eastern shore at the very foot of the Sumas mountains. Judging from the appearance of the country and the geological data one can gather concerning this region, these middens must be at least 2,000 years old.

The mounds divide themselves into two groups—burial mounds and oven mounds.

The mounds which I have taken for burial mounds are usually of large size, varying from three to twenty feet in diameter. I did not examine any of these mounds, as most of them were seen when I was making a geological examination of the region, and the time just then would not permit me to do excavation work.

The oven mounds are scattered throughout the region and northward to the Frazer river country. These were of three types—pit mounds, stone-inclosed mounds, and sand and clay mounds.

The pit mounds on examination showed that a pit had been dug in the ground and that a fire had been built in it, so that a bed of an inch or more of charcoal formed the bottom layer of the pit. The stone-inclosed mounds had the stone inclosure inside the mounds where the outer dirt had been removed by wind and water. From all appearances, the inclosure of stone in rectangular form was laid out on the ground and a fire kindled in the inclosure, as a layer of charcoal formed a stratum within the rock inclosure. The sand and clay mounds also showed a charcoal stratum in each.

These mounds were usually large, from three to sixteen feet in diameter. They were so numerous that they attracted my attention and I went to excavating them. I was of the opinion at first that they were burial mounds, though I knew that the present Indians of the region did not bury their dead in that manner when first met by the white man. My examination, however, caused me to form the conclusion that they are all oven mounds.

I found clamshells—a few only—in some of the mounds. Furthermore, on further investigation and observation I even found the Indians of the region baking claims in just such mounds. I also found an Indian and his wife baking kammas (*Scilla fraseri*) bulbs in a sand mound. I have even helped eat kammas baked in that way. These finds led me to inquire into the method of preparing food by the oven process by the Indians now occupying this and adjacent regions.

I found that in the old times, on big feast occasions, the women would go out and collect great quantities of clams and other shellfish. These they would take to the feasting place. A pit was usually dug to hold the clams, and dug in size in proportion to the clams secured A large pile of wood was heaped up over the pit and ignited, and when it had burned down to the charcoal state, thick, wet rushes or wet boughs were placed hurriedly over the heated mass and the clams poured in a heap over this. More wet rushes or boughs were placed over this, and a foot or more earth was placed over the entire heap, thus making a large mound.

Often, instead of a pit to hold the clams, a layer of stone was placed on the ground, and occasionally not even that was used. Kammas was prepared in the same manner as the clams, except that just before the last dirt was put on the mound quite a quantity of water was poured on the kammas to make them steam. The mounds, after being closed over with earth, were left to let the cooking process proceed for from twelve to twenty-four hours. Then the earth was removed from the top of the mound and the prepared food taken out. A mound with a pit in the top would mark the site of this bake. The winds would fill this pit with sand and earth and a round mound would be the result.

In cooking for a single family, of course, a smaller mound would be used. For the big feasts a whole wagonload of kammas would be baked at a time. The cooking of the kammas, no doubt, accounts for the inland mounds. No doubt, the Indians who occupied the region in the long-ago prepared food in the same manner as do the present aborigines.

Flood Myth of the Bois Fort Chippewas.

Albert B. Reagan.

Manabush is the creator god of our people (the Bois Fort Chippewas). Soon after his birth his parents were both killed by a clan of sea lions. After their death he lived with his grandmother till he became of age. He then decided to go out and avenge the death of his parents. The sea monsters who had killed them lived on an island. This was first surrounded by water for a short distance. Then for a space of about a mile and a half there was a circular band area of floating pitchlike ice, across which a canoe could not venture without certainly getting stuck in the pitch, and consequently being

captured. But notwithstanding this apparently unsurmountable difficulty, he was determined.

He told his grandmother his plans. She listened attentively to the narration, then sadly advised him not to undertake the hazardous task, though she wished to see the annihilation of the destructive sea beasts. In concluding she said "It is no use for you to fight with the sea lions on that island. Your canoe will get stuck in the pitch. Then the beasts will come out and devour you, canoe and all" But he was the more determined He made a large canoe and covered it with tallow so it would float and go through the pitch. After it was completed he made a strong bow and prepared plenty of arrows He then launched his canoe and told his grandmother to go ahead of him with another canoe in a zigzag way up the channel for a little distance at the start. (This custom of having the women proceed a war party for a little way when starting on a war expedition was long afterwards followed by the Chippewas in starting on the warpath against the Sioux.) Then when everything was ready he started out on his war enterprise.

After considerable labor in paddling and pushing his canoe through and over the pitchlike ice, he landed safe on the island in the night, where he stayed till the break of day. Then at dawn he gave the war whoop and ran for the house of the chief sea monster. Upon hearing the war whoop the king beast jumped from his bed and secured his bow and arrows, and the two powerful beings started to fight accordingly as they were gifted by their superior givers. The battle was terrible. They fought continually for two days without killing each other They then rested on their arms with the contest a draw.

But Manabush had advisers at hand. On the evening following the second day's battle, Batter, a bird of the blue jay family, accosted him and said: "You cannot kill King Sea Lion by shooting him in the body, as his heart and vital parts are not there, as in most beings" Then after a short pause he continued "I will tell you where they are if you will promise to give me some of the meat of his dead carcass"

With open mouth and wide eyes Manabush listened to Batter's statement and advice till he had closed, then replied. "My brother, if you will tell me where King Sea Lion's heart is I will give you the meat you ask and make you king of the blue jays and all meat birds."

"In truth," spoke up Batter as he flew to a limb over Manabush so as to be heard more easily without talking loud enough to be heard by any one else, "this beast's heart is in his little toe. Aim for that the next time you go to battle with him and you will succeed."

The morning of the third day Manabush gave the war hoop again. Immediately King Sea Lion came out with his full equipment for battle. The fight was on. Manabush aimed for the little toe of his adversary. The arrow struck the mark squarely and penetrated the vital regions. King Sea Lion keeled over and died there and then. Seeing his fall, Manabush ran to him, took out his big knife and scalped him. He then sailed across the surf to where he had left his grandmother, singing his song of victory as he went, as the Indians (Chippewas) have since sung when returning from a victorious battle field.

When his grandmother heard him coming singing his song of triumph, she started out to meet him in her canoe. Meeting him, she took the scalp and

went on ahead of him to the shore. Landing, she called the village neighbors and all commenced to have the war dance around the scalp in the middle of the dance hall, as it has since been the custom of Chippewas to dance the war dance down through the ages. Thus they danced till they had completed the orgy, after which they smoked the pipe of peace.

This dance lasted four days. Then Manabush bade his grandmother goodby and started westward over the earth in quest of other "hurtful" beasts. After four days of journeying he met four wolves, one of which was a chief. These accompanied him for four days in his passing westward. As he thus journeyed with them he noticed every evening when they camped for the night they would pile sticks in a heap and King Wolf would jump over the pile four times, after which the wood would catch fire without the aid of a fire starter. By watching them he also learned the art On they traveled. As they thus journeyed young wolves followed along behind and chased down the moose and deer and killed them as needed. Then they would dress and cook them and all would eat to their satisfaction; so all had a pleasurable time

After journeying four days with the wolf pack he chose for his companion one of the young wolves, whom he called his nephew Leaving the rest behind, he then proceeded on his western travels The evening of the first day after they had parted company with the other wolves they came upon the track of a moose, which it was decided his nephew should chase on the following morning That night Manabush had an unfavorable dream. The next morning, as a consequence of the forboding evil forshadowed in it, he cautioned his comrade to be careful. "The dream was about chasing this moose," he said· "It was a bad dream about you in this chase." After a moment's reflection he added in commanding order. "In chasing this moose you are to track, whenever you come to a little stream always cut a tree down and walk across it. Don't jump the stream. Be careful"

As per arrangement, the nephew started out on the chase, Manabush following his tracks. Soon he came to a little stream, over which he felled a tree, as he had been instructed He then crossed it safely. After a while he came to another small stream, which he thought he would jump, as it seemed too small to take time to cut a tree down on which to cross. Furthermore, he could see the moose only just a little farther on, staggering with fatigue, and by crossing immediately he could soon overtake it. He could even taste fresh meat, he imagined, the moose being so surely his. As he jumped the stream it instantly swelled its dimensions to a raging torrent and swept him away with it. It had been caused to become a large river by the great Snake god, who lived near a sand point that projected into the lake a little way off from the outlet of the river. This snake god's home was on an island just beyond the sand point. Here he lived in company with many other snakes and other animals that lived in the water. Here they had their lodges, as did the bear family also. These snakes and beasts were the great evil enemies of our race. To this island the wolf was taken prisoner. There he was killed and skinned and his hide was used to cover the doorway of the principal lodge of the place where the greater part of the snakes went in and out in their crawlings about.

Following along behind, Manabush tracked his nephew to this second stream, now a big river, and found that his tracks ended there. At once he

knew that he had disobeyed his orders of the morning when he had told him to cut a tree across every stream he came to. He had cut one tree down and had crossed the stream safely. Now he had disobeyed orders and had tried to jump the stream, but was taken by the current, and the stream, getting larger and swifter as it passed on toward the lake, took him out with it to the residence of King Snake. There this snake and his companions had killed him and took his hide for a door cover for the snakes' passageway. Finding that the tracks ended at the stream crossing and that he had undoubtedly been swept out into the lake, Manabush started down the winding course, hoping against hope that he might find him stranded and yet alive, or might be lucky to find his body, if dead.

He had luck in obtaining desired information. As he neared the stream's mouth he saw a bird looking down into the water. He slipped slowly up to it and made a grab for its head. Unluckily, however, he just missed his hold and ruffled up the feathers on the back of its head and neck. The bird was Kingfisher. The top bunch of feathers on his head as a pompadour Manabush made by this stroke, by grabbing him by the head and slipping his hold. Escaping, the bird flew away a short distance and lit. Then looking back and seeing Manabush, he said. "I would have told you where your nephew has gone had you not grabbed me as you did." Manabush, however, was equal to the occasion, for he knew the weak points in the make-up of the lives of all living things. So he said to Kingfisher: "Come over and tell me and I will make you a pretty bird." In consequence of this promise he flew near and told him that his nephew had been killed by King Snake, who lived near the sand point. He told him further that the snakes and bears and other water beasts come out on the sand point to sun themselves about noon each nice day, and the King Snake would be the last to come on shore. Manabush thanked him for the information, and then "fixed him up" and made him a pretty bird by rubbing his breast with white clay and painting his back blue.

Having completed his talking with Kingfisher, he started for the sand point mentioned, after he had made a strong bow and had prepared bulrush arrows, pointing them with bulrush tops. When he got near the sand beach he said to himself, "I will be a tree stub," and on reaching the place he turned into a stub of a poplar tree. Then after a while, as the sun ascended the heavens, the snakes came out to sun themselves on the sand as they were wont to do. The white bears came last, followed by King Snake. The others had noticed nothing, but King Snake at once noticed the stub.

"What it it?" he asked. On scanning it further he exclaimed: "I believe that is Manabush standing there!" He then turned to one of the chief snakes and said: "Go to yonder stub. Climb it; then coil around it and squeeze it hard.

This snake chief did as he was bidden. He coiled himself around the stub and squeezed it, but Manabush never moved. After this snake had tried his crushing powers for a considerable time he gave it up and went back to where King Snake was, saying: "That can't be Manabush."

King Snake, however, was not satisfied. He turned to a white bear and commanded him also to examine the supposed stub, saying: "You go and climb on that stub to its very top. Then slide down so as to scratch it as you descend."

The bear did as he was told. Manabush nearly yelled, the pain of the scratching was so great, but he never moved. Going back to his master, the bear then said: "That can't be Manabush." Being satisfied, King Snake then immediately came on shore and stretched himself on the sand in the sun.

After all the reptiles were fast asleep Manabush turned to be a man again. He then took out his bow and arrows and went near King Snake and shot him in his body, but without injuring him in the least. He then remembered what Kingfisher had told him—that to injure King Snake he must shoot his shadow. So with a second shot he aimed at that beast's shadow, and instantly that reptile stretched out and gasped in awful pain. Seeing this, Manabush started to run back to get a few logs together to make a raft, for Kingfisher had told him that if he wounded King Snake he would flood the world to the top of the trees in revenge. Then the water would go down again. But if he killed him, in his dying struggles he would destroy the whole world in a mighty flood. The water had already begun to rise. So he got on the little raft he had succeeded in making and floated about as he watched the water until the trees all disappeared. Then the water went down again.

After it had got dry on the earth he went back to tell Chief Wolf what had happened. After narrating this to the wolf tribe he went back to the lake where he had had the encounter with King Snake. He knew by the world's not being destroyed utterly that the snake had only been wounded. Consequently he had it in his mind to make sure of his killing him, be the consequences what they would.

As he was walking along the shore of the lake he heard something rattling. Looking ahead, he saw a large, froglike old lady of the bad witch type, jumping along. She had a rattle which she used in doctoring. She also had a pack of basswood on her back.

"Hello, grandma," he shouted to her. "Where are you going?"

"I am going to King Snake's house to doctor him," answered the frog-lady.

"Why, what is the matter with King Snake, grandma?"

"One great god, Manabush, shot King Snake for revenge."

"Grandma, teach me your medicine," broke in Manabush. "I will pay you."

Tempted with the promised pay, the old medicine frog-lady told him all about her doctoring and medicine songs. Then after he had learned all she could impart to him, he killed her, and skinning her, put the skin on himself. He then took the rattle and the pack of basswood bark and started for the village where King Snake lived. On the way he stopped where the old frog-lady lived. There he made himself much at home and waited an invitation to doctor, which soon came.

That every evening a messenger came to him saying, "Grandma, you are again requested to come and doctor King Snake."

"All right," answered Manabush. Then imitating the old frog-lady, he started to finish his killing of King Snake. Moreover, realizing the dire results that would follow, he got a lot of trees together for a raft as he journeyed to the snake's house. Getting everything in readiness, he entered the reptile's yard. As he neared the door he noticed his nephew's skin hanging as a curtain to the doorway. The sight of it made him feel so bad that he almost cried. He entered the house, they, of course, supposing him to

be the old medicine frog-lady They had him enter the room where King Snake lay very sick. On entering he took his rattles and started to sing the medicine songs he had learned from the aged frog-lady. As he sung he crawled nearer and nearer King Snake's side. As he did so he saw that the arrow he had shot at the previous time was still imbedded in the flesh with broken end still sticking out. He waited. At the opportune moment he pushed the arrow completely in and instantly killed King Snake. He then immediately fled from the house, singing to cover his tracks and to prevent suspicion.

He knew the consequence of his act and made with all speed for his raft. And none too soon, for while he was still running the water reached knee deep in depth The raft began to float away just as he got on it. Soon then the world was submerged. In this catastrophe the animals commenced to swim around trying to get somewhere where they would be safe from the raging waters. Some succeeded in getting onto the raft; others hung to it. For three days they were floating as if it were in the middle of the great ocean There was no land to be seen anywhere. The whole land surface of the earth had been swallowed up.

Manabush had forgotten to get a handful of dirt from mother earth before getting aboard his raft, he had no "starter" to commence another earth with. So on the morning of the fourth day of the tempestuous waters he called a council, saying "We must do something We cannot stay here on this raft for all time. We must get some dirt."

In accordance with the decision of the council, Manabush chose Beaver, Otter, Loon and Muskrat as divers to try their hands in getting some earth from the bottom of the deep to start land again. Beaver went down first, but died before he reached the bottom of the waters. Otter dove likewise, but died and floated lifeless over the top of the water. Then Loon went down and down, but returned without anything. He had seen the bottom of the surging waters, but had lost his life just as he was nearing the green, carpeted land and trees. When he had floated near the raft dead on his return, Manabush seized him. He then brought him back to life by blowing his breath in his face. Muskrat then started his diving. For four days nothing was seen of him. Then he floated again on the water near the raft, dead and all doubled up. Manabush pulled him aboard the raft and blowed life into him again. Then he went to examining him to see what he had found. In his hands (front paws) he found a little dirt and sand, also some in his feet and mouth. A leaf and some seed were also found. Having obtained the coveted gifts of earth, he dried them in his hands and caused them to increase till he had a handful. The act of re-creation of the world was then at hand.

Being all ready for the work before him, Manabush held his filled hand of dirt, sand and seed up on a level with his face, with palm up. At once he began to blow his breath strongly over the lump, and blew particles off it around the raft. In this way he formed an island. Immediately then the animals left the raft and began to roam over the land surface; but he kept on blowing the particles from his hand out farther and farther, thus extending the land area. He kept up this blowing till the "land could be seen out of sight." He then sent a raven to fly around the land to see how large it was. This bird was gone two days, then returned. So Manabush said: "That's too

small." He then blowed more and more and more. He then sent a dove to see how large the land surface had grown. This bird found it so large that it never came back. So Manabush was satisfied that the world (land) was big enough. He then threw down the chuncks of substance he still had in his hands, and these are the mountains of the world. He then replanted the earth with mosses, trees, herbs and grasses, after which he departed for his home

He now lives in the home of the Dawn and is the great king of all spirits.

Hunting and Fishing of Various Tribes of Indians.

ALBERT B REAGAN.

In our day many of the old-time methods of trapping and fishing of the American aborigines have been forgotten In the writer's twenty-two years living among the Indians he has picked up a few notes on the subject which he believes will be of interest to the public Some of these he here adds as follows

BRUSH FENCING FOR ANTELOPE BY THE GOSHUTE INDIANS OF UTAH

In the picturesque valley of Deep creek, Utah, surrounded by the Deep Creek range of mountains, seventy miles south of Wendover on the Western Pacific railway, live the Shoshoni-Goship (Goshute) Indians. Here they also lived when the white man came. When discovered they lived principally on wild game, which they shot or trapped, or shot or speared after trapping. In our day but little can be obtained of their method of securing game. This is principally about their method of entrapping antelope.

At several places on the bench land rows of decayed brush are noticeable in their country, some of them miles in length The writer thought at first that they were probably fences to keep sheep in bounds, but their very old appearance seemed to be against that theory. Upon asking the Indians about them they stated they were "antelope fences." They said they were built in chute shape on a large scale, with an opening now and then. They also said that although the antelope could jump, he would not attempt to go over this fence, but would follow it until he came to an opening through which he would pass to the other side. Then he would be killed by Indians lying in concealment near the opening.

HUNTING AND FISHING OF THE BOIS FORT INDIANS OF MINNESOTA.

The Bois Fort Indians, known as Sugwaundugahwinninewug (men of the dense-wooded forest) live in the coniferous forest about 140 miles northwest of Duluth, Minn., and 38 miles south of Fort Frances, Ontario. They number about 700, part of whom live on their reservation of 107,519.43 acres, surrounding a beautiful sheet of water known as Nett lake.

The land of the reservation is very variable in condition of soil and possible fertility. One-half of it is swamp and is known to the Indians as "muskeg" land. The nonswamp eastern part is composed of rock ridges of Couchiching rocks, flanked with clay land covered with pine and hardwood forest trees. The western part, which is not covered with swamp, is a sand region. Nett lake and its tributary streams occupy the east central part of the reservation

and the Little Fork and Nett rivers cross it. The swamp areas are in the jungle state. The dry land is still heavily timbered; while wild rice grows in the shallow lakes, so that they look like one vast wheat field in summer. As is seen, the region is practically in the virgin state. The same might be said of the region extending southward and eastward to Duluth and Lake Superior and northward to the Arctic ocean, much of which is composed of lakes and swamps.

This region is a paradise for fowl and fur-bearing animals. It is also a hunter's haven, and to it hundreds of people flock every fall to hunt ducks on the lakes and streams. It is also a great fur region, the Indians selling thousands of dollars' worth of fur annually.

The principal gamebirds are the following: Goosander (*Merganser americanus* Cass), mallard (*Anas boschas* Linn.), widgeon (*Mareca penelope* Linn.), baldpate (*Mareca americana* Gmel.), green-winged teal (*Nettion carolinensis* Gmel.), blue-winged teal (*Querquedula discors* Linn.), shoveler or spoonbill (*Spatula olypeata* Linn.), pintail (*Dafila acuta* Linn.), wood duck (*Aix sponsa* Linn.), readhead (*Aythya americana* Eyt.), canvasback (*Aythya vallisneria* Wills.), bluebill (*Aythya marila* Linn.), lesser scaup duck (*Aythya affinis* Eyt.), ring-necked duck (*Aythya collaris* Donov.), American golden-eye (*Clangula clangula americana* Bonap.), buffalo head (*Charitonetta albeola* Linn.), old squaw (*Harelda hyemalis* Linn.), harlequin duck (*Histrionicus histrionicus* Linn.), ruddy duck (*Erismatura jamaicensis* Gmel.), Canada goose (*Branta canadensis* Linn.), white fronted goose (*Anser albifrons gambeli* Hartl.), whooping crane (*Grus americana* Linn.), sandhill crane (*Grus mexicana* Mull.), the sandpipers, ruffed grouse, spruce hen, prairie hen, and sharp-tailed grouse.

The principal animals of the region are the caribou (now extinct), moose, red deer, skunk, white weasel, mink, otter, woodchuck, pine squirrel, chipmunk, porcupine, muskrat, gray wolf, coyote, fox, beaver, marten, wild cat, mountain lion, rabbit and bear.

The principal fish are perch, pickerel, black and rock bass, and suckers.

In hunting fowl in the old times snares, bows and arrows and deadfalls were used. Now the snare is used to some extent for land birds, but all other hunting of game birds is done with the modern gun.

The fishing is done with hook and line and with nets in summer and with home-made spear through the ice in the winter. In spearing the fish through the ice the fisherman lies down over the hole he has cut, and, covering himself with a blanket so as to make it semidark, he can see the fish swimming about. It is then an easy matter to spear them. The writer has know an Indian to spear all the fish he could carry in an hour.

In hunting animals, the big game such as the moose and deer is shot with the modern rifle. Brush fences are often piled to cause the game to go in the desired direction, so it will expose itself to the hunters. In the old times deer and moose were also enticed to approach a canoe on the lake at night. The canoe had a torch in its prow. The deer or moose had gone into the water to browse or to escape mosquitoes. Seeing the torch, he would go to it, much as a moth miller is drawn to a lamp, probably out of curiosity. Nearing it, he was shot with arrows. The same scheme is now practiced, the modern gun being used instead of the bow and arrow. Sometimes he was speared or roped and taken ashore. Torch hunting was also practiced on land.

In catching small game birds, and even wolves, coyotes, lynx and bobcats, the snare is extensively used to-day, as it was in the old times. This snare is made of sinew or of wire of the size required to hold the animal expected to be caught. "Picture-frame" wire is used in snaring rabbits and hay-baling wire for the larger game. The snaring is mostly done in winter. When a trail is discovered in the snow indicating the course taken by an animal in leaving and returning to its lair, the person finding it will search for a spot where its trail passes near a tree or through a copse. He will then take a strong sinew cord or wire, and after tying an end to something solid on one side of the trail, will make a single loop about eleven inches in diameter. He will then tie the other end of the cord or wire to a tree or log on the other side of the trail. In snaring rabbits and birds only one end of the wire is tied to some stationary thing, the other end being formed into a noose. The loop or noose is then set up across the runway by means of twigs or thin sticks placed transversely across the trail, so as to bring the loop just high enough for the head of the animal to pass through. When the animal finds itself entangled, instead of backing away it will push forward, causing the noose to tighten and strangle it to death. The writer has known a Bois Fort Indian to snare half a sled load of rabbits in a single day

Besides snaring as above, these Indians are also expert with a string. As an illustration, the writer was out surveying with two Indians. A spruce hen was heard to flutter in a near-by tree The guide to the party sat down and took a shoestring out of one of his shoes and tied it onto the end of a stick; then made a noose in the free end. He then walked slowly up to the tree where the bird was, and with slow movement pushed the stick up past the bird so that by considerable maneuvering the noose fell over its head. A quick jerk then brought the bird down, and we had it for dinner.

In trapping animals the white man's steel traps are now extensively used. The Indian style of trapping is also still in vogue. Two systems are resorted to—the bear trap and the stake trap. Both are of the deadfall type.

The bear trap is a sort of covered pen, so made of upright posts as to leave but one entrance, to which a chute often leads. Through this the bear is compelled to pass to reach the tempting bait of meat, placed in the far end of the pen. This bait is fastened to a tiny cord. The roof of this pen is a deadfall, consisting of trunks of trees weighted down with rock sufficient to crush the beast. A disarrangement of the bait trips the deadfall. Beaver traps are made much the same way, but baited with some vegetable substance of which these animals are fond. Similar bait colored with vermillion "medicine" is also placed between two two-inch sticks laid crosswise of each other and then attached to steel traps when trapping beaver in the modern traps.

The stake trap consists of four upright posts set in the ground in such position that the ground plan between them forms a parallelogram. A floor is made of logs the long way of the space thus inclosed. A weighted roof is then placed between the posts parallel with the floor. A stake is then set without the inclosure at two alternate corners, and a brine-soaked rawhide cord is loosely stretched under the roof across the floor space between the stakes. A heavy stick or small pole is tied to the roof logs at one end, being placed as a lever over one corner post as a fulcrum; its other end is tied by a buckskin cord in loop style to the transverse buckskin cord above men-

tioned. Thus is the roof held up by this lever and the two cords. Stakes are then set so that the animal must enter the trap at the front entrance The salted cord is a sufficient bait to tempt a rabbit or other rodent to enter the trap and gnaw the cord; and if gnawed in twain, the supported roof is dropped on the animal's back, and it is thus secured without injuring the pelt.

A HOPI DEVICE.

The Hopis catch small animals by a trip-trigger deadfall. The Hopi takes a thin, flat rock of considerable size This he raises on one edge over some level spot and tips it to about a 45-degree angle. He then places a support post, a small but strong stick, just without the front edge of the rock thus tipped. On top of this post between it and the rock he then places a horizontal, projecting short piece of wood. This is so beveled at the end over the post that it fits the space between it and the under surface of the inclining rock and projects under it enough to support it The outer end of this piece has a strong cord tied to it of a length that it can be wrapped once around the base of the upright post. This cord has a small stick tied to it through its middle This cord he wraps around the post from left to right one wrap, so that the stick is on the right side of the post Then under the rock, in line with the upper horizontally projecting stick, he places the bait stick. This he places with one end against the rock at its base The other end he places against the end of the stick at the end of the cord, wrapped as mentioned. In this sort of pry position it keeps the string from being unwrapped, but its least move releases it, and down comes the whole structure The bait stick is then baited The bait is anything suitable for the animal desired to be caught This is usually wrapped in thin cloth, so that the animal will have to pull and tear the cloth to get the bait

HUNTING AND FISHING OF THE QUILLAYUTE INDIANS.

The Quillayute Indians live about thirty-six miles south of Cape Flattery on the Pacific coast of the Olympic peninsula, Washington. In the main, they are a fisher people and their methods of fishing and hunting are very similar to those of the other west-coast Indians.

CATCHING LAND ANIMALS AND BIRDS. In hunting large land game the modern gun is used at present, but in the old times the bow and arrow was used to effect. Game was also driven into pitfalls or onto points of land that projected into the ocean and slaughtered there. The snare was also extensively used. These were usually made of braided or twisted rawhide strips or pounded spruce-root fiber, inner spruce bark or cedar fiber. Animals were also stampeded onto pointed stakes and killed

In the hunting of smaller animals, such as skunk, racoon, wolf, and so on, white man's traps are now used. The traps are placed in the animal's burrow entrance and carefully covered with leaves and earth. Sometimes they are placed in the runways. At other times they are set at the foot of trees, properly concealed with earth and leaves. Then above each one there is suspended the proper bait for the animal wished to be caught. And they get the animals, too. Deadfalls are also used; some with salted-cord trigger, others with the baited figure-four contrivance. Some animals were speared in their burrows—the muskrat, for instance. Much of the trapping is still done by the ancient system.

In capturing birds, especially in the old times, the eggs and young were taken from the nests, the young just before they were ready to fly. The parent birds were also killed while nesting. The method of securing them was by the slipping-up method: Snares were also used at the nests to capture the parent birds. Birds were also killed with darts and arrows. Baited deadfalls and "figure-four" traps were also used in slaughtering birds.

HUNTING THE SEA OTTER. The sea otter was killed with a club or spear when found on land in the old times, and still is. On the sea he is slipped up on while asleep and speared with a two-pronged, long-stalked spear. The Indians say that if it is shot it will sink and be lost. So they still hunt it in the ancient way.

HUNTING SEAL. The Pacific waters adjacent to the Indian village abound in both hair and fur seal The fur seal is, of course, killed for its valuable fur, though the Indians are fond of its flesh and use its paunch to store whale oil and salmon-egg cheese The hair seal is also killed for its flesh and for its skin and paunch The skin, besides being used in making various articles of clothing, is turned inside out, its openings securely shut, after which it is inflated and used as a buoy in whale hunting Both of these animals are slipped up on at their feeding grounds or while basking in the sun on the rocks They are then harpooned with a double-headed native harpoon like the one mentioned above If the animal is in the water or near it the modern gun is never used, as the beast would immediately sink and be lost

HUNTING SEA LION. Many of the islands along the coast are basking places for sea lion The beasts are usually attacked while lying asleep on the rocks, as they seem to go farther from water than the seals Guns are now used in hunting them, also two-pronged spears If the animal is in the water or near it the latter is the preferred weapon, provided they are supplied with buoy attachments

FISHING In the old times fish were speared or killed with clubs and caught in nets of spruce root or rawhide Hooks of bone, and U-shaped spruce roots with barbed points of bone, were also used in fishing. The U-shaped hooks were large and were used in catching halibut along the halibut banks. A very similar hook, though smaller, was used in catching rock cod and other allied fish. The line used in deep fishing was a kelp stalk, a spruce-root or cedar-bark cord.

Smelt fish (Pacific sardine?) was caught with a cordage-made dip net. This was pyramidal in shape and of about a bushel in size. In fishing for this species the fisherman wades out into the serf and dips up the incoming fish in a motion much like that used in scooping corn The fish run inshore to spawn at certain seasons of the year, one species (a small fish) in March and February and the larger kind in May and June.

Various traps are also used. The stockade trap is the one most seen. This is placed completely across the stream in stockade style. About the center there is a box-trap-shaped contrivance so arranged that a fish can go over a slanting roof-piece trap door and fall into the space beneath it within the inclosure, from which it cannot get out. His going over this trap door throws up a signal board, which indicates that a fish is in the trap. A single trap of this style has been known to catch more than a wagonload of fish in a

single day. One of the other traps used is a cone-shaped affair, constructed much like a wire rat trap, in that when a fish gets into it it cannot get out. Stockades are often used to force fish into these traps. Modern fish traps are also used.

PORPOISE HUNTING. In hunting porpoise a canoe is noiselessly shoved onto the unsuspecting beast, which is harpooned with a heavy weapon, to which buoys are attached, as in whaling, next described The animal is quick and usually puts up quite a fight for its life, but if the harpoon is once driven deep into its body its capture is sure.

WHALING. The implements used in whaling are a two-ton canoe, innumerable inverted hair-sealskin buoys, harpoon stalks and blades, sufficient rope, and plenty of knives.

After elaborate ceremonies to make the whalers "not afraid," the whaling crew—or crews, as usually from five to seven whaling canoes go on a whaling trip—pushes out into the ocean. Seeing a whale spouting, they push their canoe noiselessly onto the unsuspecting animal, and before it is aware of their presence a huge harpoon, to which a rope of buoys is attached, is driven deeply into its body. It dives and comes to the surface dragging the buoys after it, only to be attacked again. Thus is the contest kept up till the beast floats lifeless. It is then towed ashore and cut up Both the meat and blubber and much of the bone is saved, the last being made into knives, spears and harpoon points in the old times. At the close of caring for the valuable parts, a give-away feast and dance of four days' duration is given in the *potlatch* (city) hall of the village and all are made happy.

Frogs and Frogging.

E C O'ROKE

Out in Wyoming the ranchmen have a friendly card game called solo, which is so fascinating that were it played in the daytime and participated in to a greater extent by the female of the species it would rival auction bridge as a time killer. A favorite bid in solo is "I frog." Having sat in and sat out in these friendly games—for sitting out while others sit in is part of the fun—the writer can vouch for the enjoyment that the players experience. But whether the question of frogging is what makes the game attractive should be left to the psychologists. However, be that as it may, frogging in the real sense is a sport that has the proverbial snipe hunt beaten a long way, and the evoluted cave man who has not felt with his bare hands the cold, slippery body of a frog and held the croaking creature firmly throughout all his efforts to escape does not know the supreme thrill of achievement that comes to the successful hunter.

Many books have been written about frogs, and in them the amateur or the investigator can find many of the finest things in modern biology. But as far as frogging is concerned, a search through literature reveals the meagerness of our information concerning this popular sport.

"How far can a frog jump?" is often asked in laboratory outlines for the study of this master servant of biology. The student in his zeal to answer

the question takes a tired laboratory specimen, urges it onward by a few variously applied stimuli, and comes to the conclusion that twelve inches represents the extreme effort of a frog in this characteristically froglike method of locomotion. Had he gone frogging instead, and happened to come across an adventurous and well-fed *Rana pipiens* a couple of rods from water, and headed towards that universal commodity on a slightly inclined plane, doubtless his answer would have been different; if also the *Rana pipiens* had been *Rana catesbiana* instead, and this individual had had a straightaway course over firm mud, the frogger might well have answered, with greater scientific accuracy, several feet, and any inaccuracy of statement could have been checked up by the bullfrog's written record in his own handwriting.

Frogging offers splendid opportunities to learn of the habits of these most common amphibia The writer's earliest recollections of the sport concern a group of small boys and some small spotted frogs The frogs jumped into the water, and so did the boys; in fact, they buried themselves in the mud, and the boys in attempting to catch them came very near doing likewise. Result. a catch of three small frogs and prospects of catching a licking on the part of three small boys. The next time the writer went frogging he had a twenty-two rifle, but he had not learned that a frog is supposed to have a medulla. Result three small frogs as before, and the remarkable scientific deduction that you can kill a frog by shooting clear through him but he won't die.

Frogging, like many other things, depends upon the time and place. The object that the collector has in mind is also important. For instance, if it isn't frogs but frog eggs that the investigator wants, he must be ready to go collecting at the first call of spring. The breeding season of the *Salientia* varies with the climate, and is announced by the croaking of the frogs as early as March and February in some localities and not until May or June in others. In fact, the writer has found twelve-millimeter toad tadpoles, probably *Bufo lentiginosis woodhousei* as late as July 19 in high mountain regions in Wyoming

Since frog eggs and developing larvæ can be shipped easily, a knowledge of the time of their appearance in various localities would be extremely useful to the investigator in experimental zoology who might want to keep on hand small larvæ at various times of the year

In collecting frog eggs for preserving for cleavage studies, it is necessary to go before sunrise in the morning if one wishes to secure the earliest stages. The writer has found it good practice to take along several shallow containers and a bottle of formalin. Upon finding the egg masses it is but the work of a few moments to identify with a good hand lens the stage of development of the eggs. They can then be put in the shallow pans of water and allowed to develop to the proper stages before being fixed. By this means the writer has been able in a few days to secure large numbers of complete series of early stages, which at biological supply-house prices would be worth several hundred dollars. The later stages of cleavage and early embryos, as well as tadpoles of different ages, can be readily obtained by taking these early stages to the laboratory and allowing them to develop to the desired stage.

A note as to where frog eggs are most likely to be found may not be amiss. The little *Chorophilus* eggs, though small, make beautiful cleavage studies.

They can be found very readily in temporary pasture ponds where there are old sticks and grass or weeds to which the eggs may be cemented. These egg masses are elongate, rarely more than an inch or two in length, and quite transparent. The egg masses of the leopard frog, on the other hand, may be as large as one's fist, and are very dark in color, due to the pigmented upper half of the eggs. Consequently these egg masses are harder to find, especially in murky water or against a dark background. They are deposited in deeper water than those of the *Chorophilus,* usually at a depth of from eight inches to a foot. Quiet water, such as drainage ditches in open flats, offers good opportunities for collecting. In the Laramie valley in Wyoming the best place to find *Rana pipiens* eggs is in the low flats near the river, which become filled with water during the spring overflow. Perhaps this choice of environment on the part of the frog has a good deal to do with the preservation of the species, for the spring overflow, being the result of melting snows in the mountains, does not come until the country has warmed up in general. When this overflow once arrives the low places become pools of stagnant water, which last for several weeks. They develop a rich supply of food for the developing tadpoles, and thus the chances for the preservation of the species are optimum.

Perhaps the best-known method of collecting frogs is that of blinding them at night by means of a flash light or acetylene bicycle lamp. With the light in one hand, the collector walks quietly up to the edge of the pond where the frogs are sitting with their heads out of the water. He brings the light down to within a few inches of the frog's eyes, at the same time allowing the other hand to close quickly and firmly over the unsuspecting prey. A gunny sack is the rest of the necessary equipment, and like the proverbial snipe hunt, it works better if you take some one along to hold this container. The use of a small hand net instead of the bare hand may insure a larger percentage of safe catches. The loss of a frog or two in itself is not serious, but when one jumps away he frequently gives a fear call that frightens others near by that might have been legitimate prey. This method of collecting has netted the writer dozens of large bullfrogs in ponds such as those at the State Fish Hatchery at Pratt, Kan.

When bullfrogs or other large frogs are desired for food or for examination for feeding habits or parasites, and where it is not necessary to take them alive, shooting with a twenty-two rifle is effective. This method works well in the early morning when they are too alert to be captured in a net. It is needless to say that frogs must be shot through the brain.

Fishing for bullfrogs with a long bamboo pole and short weighted line baited with only a hook and a piece of red flannel is another method of catching these largest of frogs. The fisherman sees a frog sitting on the bank, and sneaking up from behind, swings the bait in front of the game. When the creature leaps and grabs it all the fisherman has to do is to swing him quickly to a place of safety.

In the lake regions of the northern United States in the fall before the shallow lakes freeze over, frogs congregate in enormous numbers about the edges of the lakes, and leaving the water temporarily, crawl into cracks and crevices in the banks and about the roots of trees. Under such circumstances one can readily obtain any number of them. Last fall the writer was

introduced to this kind of frogging on the shores of Lake Campbell, near Brookings, S. D. Leopard frogs of all sizes were to be found literally by the thousands. All one has to do is to reach his bare hand into the holes and pull them out by the handfuls. What an opportunity for obtaining large numbers for laboratory use or for examination for parasites! So far as the writer knows, the only use that is made of them in the above-mentioned locality is that picnic parties go out to the lakes and enjoy a mess of frog legs in season.

Thus in brief are a few pointers on frogs and frogging gleaned from the writer's field notebook. They are submitted for publication in the hope that others will find them worth while.

The Industrial Research Movement of To-day.

W F FARAGHER.

The ambition of every healthy business is growth. Whatever may be the chief motive which impels an individual concern towards this goal, it is certain that a desire to render the largest possible measure of service to society is a salient factor in its program of development. For the firm typical of the times, the mercenary aspects of this principle are recessive. With the more general adoption of this method of conducting, results of a revolutionary character will be achieved, and the establishment of our national commercial activities upon an unassailable foundation assured.

The importance to our nation of a fully developed, virile manufacturing activity cannot be overestimated. Not only must the diversified needs of our own people be cared for efficiently, but also the requirements of foreign markets must be supplied in as large measure as is possible in view of the many handicaps which we suffer. We have been too long content to control the balance of trade by the exportation of raw materials and of commodities the value of which has been only slightly increased by fabrication. We should, particularly at this period of readjustment of world commerce, strive to put ourselves in a position to furnish, in competition with the world, articles which have increased value because of their uniqueness in meeting man's requirements or because of the skill and outlay expended in their preparation.

It is not difficult to show that most of our successful and desirable innovations in industry have been developed around invention and scientific experimentation or research. Formerly no close distinctions were drawn between these two functions, as a rule. Very frequently, also, the invention or research was not directly associated with the business which reaped the reward. We may now, however, assert that all properly planned and properly executed research is remunerative. Furthermore, it is now established that any technical business which wishes to expand as it should must in some way avail itself of technical, *i. e.*, chemical and engineering, research. In the sense here intended, research covers all activity which looks toward the application to a given factory process or product of any available chemical or engineering knowledge not currently employed in connection with them.

The business world has for a long time been familiar with various methods of insuring against discontinuance in the face of certain disasters—insurance

policies in favor of the company covering the life of an indispensable officer, policies covering bad accounts, and sinking funds accumulated in times of prosperity. It is high time, however, that all of our industrialists know that there is available an insurance of a higher type than any of these—organized research. Not only will such research insure that a business will continue uninterruptedly in the old way, but also that it will expand normally by improving its processes and its products, and also in some cases by finding new uses for its products and byproducts. Organized research is at once an investment and an assurance of future growth and activity.

Although there have always been active centers of research and competent research men imbued with the importance of their labors, the commercial world had, until comparatively recently, failed to see in these agencies the potent instrument for extension which is so greatly needed. The average industrialist, if he were cognizant of these activities at all, regarded them as something wholly academic and consequently of no concern to him. It is true that in the beginning the problems of the majority of these researches were those of pure science. The data which were accumulated were in many instances of the highest quality, and are even now considered to be classical. Work of this character is fundamental and therefore indispensable to all technical business. It is not surprising, however, that in spite of this satisfactory growth in pure science, the recognition of the value of organized industrial research was only slowly realized. Fortunately, there have been from the beginning of our commercial development isolated examples of organized research in industry which proved to be highly successful. The number of these departments had increased relatively very greatly by the beginning of the present century, and the possibilities of industrial research were being considered favorably by a growing circle of our foremost industrial organizations. The old belief that industry can be assisted only by those actively engaged in the productive phases of industry was placed well on the defensive. The newly demonstrated, or rather, slowly established, fact was the adaptability of the research methods and the data of pure science to the problems of industry.

An interesting example, and an extremely valuable one, of a serious attempt to foster the research movement in industry is presented in the work of the Mellon Institute of the University of Pittsburg This institution is an outgrowth of a department of industrial research established at the University of Kansas in 1907 by the late Dr. Robert Kennedy Duncan. At this time, as indicated above, the desirability of organized research in industry was appreciated. The whole subject of the proper organization of industrial research was so new, however, that progress was still relatively slow. The most successful installations of research laboratories were those of some of our large corporations. There research departments had grown from small beginnings, through the vicissitudes of repeated reorganizations, to positions of first importance to their respective companies. The mutual understanding of industrialist and research worker was still so unsatisfactory, however, that the founding of a department of research by an industrialist was a considerable financial hazard.

Recognizing all of these conditions, Doctor Duncan formulated a plan for introducing individual firms to organized research on their own problems, and

for training men educated in the methods of research in pure chemistry to become leaders in their selected fields of technical research. By a fortunate circumstance Doctor Duncan was enabled to inaugurate the work at Kansas soon after he had perfected the fundamental principles of the plan. Briefly stated, the plan provided for the founding of temporary industrial fellowships at the University of Kansas by individuals or corporations who had specific chemical problems the solution of which were needed in industry. By the payment of a fixed sum annually for a period of one or two years the individual or corporation became the donor of such a fellowship. Renewals were possible if agreed upon. Exclusive rights to the data obtained and to the patents issued to the fellow belonged to the donor for a period of years. The selection of the research man, the fellow and the supervision of his work were the duty of Doctor Duncan, and subsequently of a committee of men who knew both the methods of research and those of the commercial world. The function of the University as a creator and distributor of knowledge was preserved by a provision in the contract stating that after a specified time a complete report of each research could be published by the authorities of the University. In this way the interests of all parties to the contract were cared for adequately. A capable research man was thus enabled to carry on work on an important technical problem, under proper guidance and in an atmosphere which tended to stimulate him to his greatest efforts. The advantage of the use of expensive equipment and apparatus was enjoyed at a minimum expense to the donor. With proper regard to the secrecy which had to be observed in the interests of the donor, consultations with trained scientists of the University staff were provided for.

Such was the plan of Doctor Duncan, which he conceived at the meeting of the International Congress of Applied Chemistry in Rome in 1906. Doctor Duncan went to Rome for this meeting after he had made an extended tour of inspection and study of the technical activities of Germany and France.

After his return to the United States Doctor Duncan, who was the scientific editor of the Harper periodicals, published a series of articles on typical American industries in *Harper's Magazine*. In one of these articles, which treated upon the textile industries, Doctor Duncan referred to the large economic waste which was occasioned by the use of inefficient methods in the power laundry and in the textile bleachery. He stated emphatically that the destruction of fabrics was criminal and could be avoided by the discovery through intensive research of proper methods of working. This scathing indictment of the power-laundry industry by the champion of the research ideal made a strong impression upon Mr. E. Ray Speare, who showed his broad-mindedness and progressiveness by requesting Doctor Duncan to outline a plan for inaugurating the suggested research. The support for the work was promised by the Alden Speare's Sons Company, manufacturers of power-laundry supplies. The meeting of an enthusiast in the research ideal with a business man of broad vision was effected. Vigorous correspondence between these two principles perfected the details of the plans which Doctor Duncan had formulated, and the project of temporary industrial fellowship was launched speedily. Within a short time other business establishments availed themselves of the opportunity afforded by Doctor Duncan's enterprise. Researches in the chemistry of baking, of diastatic ferments for pharmaceutical use, of

the preparation of casein from buttermilk, of glass for illuminating purposes, of cement and hydrated lime and of petroleum and its products were soon under way. The plan was thus assured of a thorough trial, and all concerned made every effort to insure its success.

After about three years of operation, during which time results were obtained which were satisfactory to all parties concerned, Doctor Duncan was called to the University of Pittsburg to develop his scheme of temporary industrial fellowships on a still larger scale. Besides founding the research department at Pittsburg, Doctor Duncan continued for a year or two to direct the greatly enlarged department at the University of Kansas. By this time, however, the demands of either school had become as large as one man could meet, so Doctor Duncan chose to confine his efforts to the work at Pittsburg. The chief factors leading to this decision were the favorable industrial environment of Pittsburg and the financial support which the project received, strictly upon its merits, from the Mellon brothers, prominent bankers and "captains of industry" of Pittsburg.

The considerable growth of the department of research even at this time called for a greatly enlarged staff of directors, increased laboratory space and valuable special apparatus. In order to place the work of Doctor Duncan on a permanent basis, thereby rendering an invaluable service to the people of the United States through the industries which supply their needs for various commodities, the Mellon brothers donated a sum of money to erect a suitable building to house the research men and the administrative staff, and to endow the institute sufficiently to enable it to meet the expenses of administration, the addition of permanent mechanical equipment and the necessary operating expenses. None of the money paid by donors had been available for any of these purposes, so the gift of Messrs A. W. and R. B. Mellon was timely, since the institute was demanding more funds than might well be asked for from a single university. The greatly enlarged institute, now housed in one of the finest buildings for laboratory use to be found anywhere, is at once a memorial to Doctor Duncan and to Judge Mellon, father of the Mellon brothers, who was a forward-looking business pioneer of Pittsburg.

The experimental stage of the system of industrial fellowship may fairly be considered to have been passed in February, 1915, when the permanent house was occupied. The number of fellowships in operation at that time was 23, and the number of fellows or research men was 35. The total annual sum contributed by donors then amounted to $65,000 This money paid only the salaries of the research men, the cost of chemicals and special apparatus used in their researches and the traveling expenses incurred in the pursuance of the researches. At the same time the institute was expending annually about one-third of this amount to take care of the members of the permanent staff of directors, the salaries of the office force and the maintenance of building, permanent apparatus, etc.

The soundness of the fellowship scheme is now generally recognized. Forty-seven fellowships are in successful operation, to the support of which $238,245 have been donated. The institute *per se* is expending $65,000 per annum in maintaining the staff and building. The administrative staff now numbers six, and the fellowships, employing about 70 men, are distributed among these directors according to their specialties. The favorable reception

of the opportunity to engage in research by this method on the part of our foremost industrialists is attested to by the everincreasing number of fellowships which are offered. At the present time no solicitation of donors is necessary, and there is, in fact, a waiting list of firms desirous of establishing researches. The accepting of these offers is contingent upon providing suitable accommodations in the already crowded building and upon the selection of research men who by temperament, training and experience are peculiarly fitted to undertake the researches. The appeal to the research workers of the country is very strong, and the list of applicants includes not only large numbers of the most promising men who are beginning their careers in research, but also many of the best research workers with established records of sound accomplishment.

During the eight years from March 1, 1911, to March 1, 1919, the total amount of money contributed by industrial firms or donors was $919,745. The institute itself provided during this same period over $330,000. Basing their decisions wholly upon the benefits derived, many donors continue to renew their fellowships, and new firms, after careful investigation of the results obtained by others, are eager to participate in the operation of the system. In many instances firms are instructed in the value of research as a result of their experience at the institute and proceed to install complete research laboratories of their own. Here, then, is one line of proof that properly planned, properly executed research is remunerative

As a result of the successful work of Mellon Institute some of our universities have inaugurated programs of industrial research. In every instance they have met with the heartiest cooperation from the institute in formulating their plans and in making the changes from the established policy of Mellon Institute which individual circumstances dictate. The field is too large for any one institution, and the pioneers in the work welcome the accession of all units which give promise of helping to establish the research movement in industry. The adoption of similar methods by foreign universities has followed, and the results obtained prove that the system is sound in the new surroundings also.

The unprecedented demands which were made upon our industries as a result of the war have emphasized as nothing else could have done the essential part which research plays in industrial progress Our shortsightedness in having entered so slowly into industrial research was very quickly made apparent. No time was lost, however, in establishing the laboratories which were needed so greatly. In spite of the difficulties attending such installations, and of the mistakes which were inevitable in proceeding so hurriedly, the cooperation of our men of science and our leading industrialists has resulted in a development which is without equal. The value of the right kind of research is unquestioned. Firm after firm which formerly had nothing to do directly with research is now planning to secure the benefits which are practically assured by the utilization of research methods. The question is no longer one concerning the desirability of research, but rather one of the proper organization of the research activity in a given business. Even the laboring classes now appreciate the fundamental importance of research to the economic life of the country. The resolution indorsing industrial research which was adopted by the delegates to the convention of the American

Federation of Labor at Atlantic City this summer is unique, and will prove to be of first importance to our country. Therein is embodied an idealism as well as a sane, practical program, which are worthy of any group of men whatsoever. The resolution is well worth the consideration of our industrial leaders and deserves the favorable action which it requests of congress. Again, representatives of the 119 national and international unions called together by President Gompers of the American Federation of Labor in conference at Washington during December, 1919, in their impressive bill of rights have inserted the following paragraph

"To promote further the production of an adequate supply of the world's needs for use and higher standards of life, we urge that there be established cooperation between the scientists of industry and the representatives of organized workers."

Many of our foremost industrial organizations now have complete departments of research In practically every instance the research laboratory has proved to be indispensable and its value to the business served is fully appreciated by the whole business organization. As example of highly successful departments of research, we may mention those of the Eastman Kodak Company, Aluminum Company of America, General Electric Company, the National Aniline and Chemical Company, the Du Pont Company, the Westinghouse Electric and Manufacturing Company, the National Carbon Company, the Hercules Powder Company, the United States Steel Corporation, the General Chemical Company, the Barrett Company, and the Goodyear Rubber Company. Many of these concerns consider their research efforts to be not only a benefit to themselves, but also an advantage to their customers, who share in the results of the laboratories' successes through improved products and decreased costs made possible by improvements in processes.

The small business has greater need of research activity than the powerful corporation, on account of the relatively greater overhead per unit of production which the former generally bears. It is imperative, however, that all mistakes in installing a research organization in a small business be obviated. The large concern can weather the disaster of even considerable losses due to faulty organization, but the small business must be assured that its program is sound before it proceeds. Fortunately, several methods are available for small concerns to engage in industrial research. In the first place, a small business may establish its own laboratory. There are numerous instances where this policy has been followed with the most successful results. By way of illustration, we may describe briefly the experience of Leeds-Northrup Company, manufacturers of electrical measuring instruments. In 1912, when the research laboratory was founded, this firm was doing a volume of business of several hundred thousand dollars per year. In laying down the policy of the department, an almost ideal working program was arranged. It is not too much to say that the greatest factors insuring the success of such an undertaking are the selection of the proper personnel and the relationships maintained between the research department and the executive and technical directors of the business. The general policy of the Leeds-Northrup laboratory was decided upon by a committee consisting of the heads of the research, sales, production and engineering departments. The question of problems to be attacked and decisions concerning the completion of certain re-

searches and the discontinuance of others was the province of this committee. Responsibility for the details of the work done rested properly upon the head of the research department and his associates, men trained in the prosecution of research. It is noteworthy, too, that the head of the research laboratory was treated as a reasonable member of the business and was not subordinated to a factory superintendent or to a manager of sales, for example. Complete records of the cost of each research were kept by the accounting department, and each accepted result from the laboratory was credited with its earnings, just as if it were a project submitted from the outside. In seven years the annual expenditures for research have increased from about $10,000 to about $35,000 per year. Within about six years from the start the total credits had equalized the total charges for research, while during the next two years the credit balance increased at a rapidly accelerated rate.

Another method of organizing research which is especially attractive to small concerns is the establishment of a research laboratory or of an industrial fellowship by an association of manufacturers. The latter of these schemes was first proposed and carried out by the Mellon Institute. Subsequently, the National Canners' Association established their own laboratory at Washington. At the present time there are in successful operation at Mellon Institute eight of these association fellowships. The problems dealt with are those of the leather-belting, refractories, sheet-metal, magnesia, asbestos, fiber-board, insecticides and laundry industries. This type of fellowship is particularly valuable, as it enables the institute to be of direct service to large groups of industrial concerns. Moreover, the successful operation of these fellowships gives rise to more stable relations of coöperation among the members of the associations by the introduction of the reciprocal exchange of experience and research results

Still another method for securing direct benefit from research, which is also particularly applicable to small businesses, is the cooperation of commercial research laboratories There are at present a number of these laboratories which specialize in problems of industrial research. Specific problems are accepted by them for investigation, or a general study of factory processes and products will be made. Work of this kind is arranged for on the basis of a schedule of fixed fees.

Beside the agencies furthering research which have been mentioned, others have sprung up which promise to contribute valuable results. During the war the Council of National Defense provided a useful organization which made considerable progress towards introducing research methods into industry and standardizing the methods of organizing research projects in industry. As a result of the activities of the reorganized National Research Council it has been shown that in spite of the substantial progress which research has made in this country, the program is still in its initial stages. Of the 275,000 manufacturing concerns in the country, fewer than one-fourth of one per cent have laboratories of any description. Only half of these laboratories are what they should be, while the number of research laboratories is pitifully small. The new function of the Research Council is to assist in organizing group research undertakings. One project under way is the establishment of a research laboratory for investigating alloys. As at

present planned, the contributing members are to be largely manufacturers who need alloys with special properties, rather than those who make alloys. One hundred members, each contributing $100 annually for five years, are considered necessary to insure the success of the project. In a similar way, other groups of industrialists are being interested in research with good prospects of success.

Renewed interest in research is being displayed also by certain departments of the government. Budgets for research activities are provided for on an enlarged scale in the deficiency bill now under consideration by congress. The total for industrial research is $250,000. A special bill to defray the costs of investigation of the production of oil and other products from oil shale has been proposed by Senator Henderson, of Nevada. After a careful review of the situation, passage of the bill or of a similar one was recommended by Secretary Lane, to whom the above bill was referred for a report by the senate committee on mines and mining. Although the government bureaus have been active and successful in research work in the past, the demands for the present are insistent for their enlarged participation in industrial research.

A further example of group research is furnished by an announcement of the recently organized Petroleum Institute. This association is composed of the executive officers and of the principal technical directors of the prominent companies of the petroleum industry. Their program of research, which is to be started at once, calls for the expenditure of $500,000 annually. Besides the technology problems of the industry, such as the improvement of methods of distillation and refining, and the recovery of acids used in the refining of distillates, the institute plans to study the economic and statistical phases of the industry also. The character of the men supporting the project and the ample funds which the institute is providing insure that not only the petroleum industry but also the public will receive large benefits from this undertaking.

Practically all of the methods of conducting research in industry which have been described as important ones in the industrial life of the United States are being utilized in foreign countries. England, France, Japan and Canada are particularly active in this line of work. Germany had early taken advantage of research in her industries and will certainly resume the practice as soon as conditions become at all settled. In England and Japan, at least, the movement is being assisted in certain instances by the governments in a way which amounts practically to a subsidy. With such keen rivals, we must develop our own research projects to the fullest possible extent.

Any of the research organizations which have been mentioned, and any others which may be developed, call for careful consideration of costs. Obviously, every individual research problem engaged in cannot show a profit to the company concerned. Neither does every advertising campaign nor every change in factory processes developed in the old way bring returns. All of the data at hand, however, prove that, considered as a department, the efficient research organization is an asset.

During the year 1918 there was expended for chemical laboratory research alone by American industrialists about $10,000,000. It is impossible to state how much more was expended in experimentation in the factories themselves. As a rough guide to the expenditure which is required to install a chemical

laboratory, it may be taken that the first cost of the laboratory will be about $3,500 per scientific worker employed. The annual cost of maintenance of such a laboratory is probably about the same amount per man, on the average.

As is the case in other departments of an organized business, the greatest problem in research administration is the securing of qualified investigators. The failure of the research organization in a given instance is no indictment of the system of research, but rather of the individual director of research or of the scheme of organization under which he was compelled to work. The newness of research activity has already begun to pass and the problem of training research men is being met more and more thoroughly by our schools. Capitalization of the fund of experience already acquired and the increasing supply of properly trained research men now make possible the founding of adequate research departments with no considerable element of risk.

Finally, our universities or technical schools—although in a manner awakened to the importance of this research movement—have still a long way to go. There is no reason why every such school should not perform the functions of the Mellon Institute to a greater or less extent. The academic viewpoint of the ordinary college professor must be changed and such schools be led to realize the great opportunity offered them of joining science with business in a union that will be happy for both.

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OF THE

KANSAS

ACADEMY OF SCIENCE

Volume XXXI

Fifty-fourth Annual Meeting, Manhattan
February 17-18, 1922
Fifty-fifth Annual Meeting, Lawrence
February 16-17, 1923
Fifty-sixth Annual Meeting, McPherson
April 4-5, 1924
Fifty-seventh Annual Meeting, Manhattan
April 10-11, 1925
Fifty-eighth Annual Meeting, Winfield
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Printed by Kimball Printing Co.
Manhattan, Kansas.

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years, having been annually notified of their arrearege by the treasurer, shall have their names stricken from the roll.

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VII. Eight members shall constitute a quorum for the transaction of business.

VIII. The time alloted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

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1869, 1870	B. F. Mudge
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1874—1878	F. H. Snow.
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1921	O. P. Dellinger.

MEMBERSHIP OF THE ACADEMY

1922-1928

Abbreviations. The following abbreviations for institutions have been used:

K. S. A. C. Kansas State Agricultural College.
K. S. T. C. Kansas State Teachers College
U. of K. University of Kansas

Other abbreviations follow those used in the Summarized Proceedings of the American Association for the Advancement of Science

The year given indicates the time of election to membership

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Baumgartner, William J., A. M., 1904, assoc. prof. zoology, U. of K., Lawrence, Kan.
Beede, Joshua W., Ph. D., 1894, prof. geology and paleontology, Indiana Univ. Bloomington, Ind.

Bushong, F. W, Sc. D., 1896, 2636 F'fth St, Port Arthur, Tex.
Cady, Hamilton P, Ph. D, 1904, prof chemistry, U of K, Lawrence, Kan
Copley, Rev. John T, 1903, Olathe, Kan
Cragin, F W., Ph D, 1880, 912 Migeul St., Colorado Springs, Col.
Crevecoeur, F F, 1900, Onaga, Kan
Cook, W A., M. S, 1907, real estate business, 1414 Highland St., Salina, Kan
Dains, F. B, Ph D, 1902, prof chemistry, U of K, Lawrence Kan.
Deere, Emil O, M. S 1905, dean and prof biology, Bethany Col, Lindsborg, Kan.
Dunlevy, R. B, M A, 1896, Southwestern Col, Winfield, Kan
Eby, J Wht, B S, 1903, banker, Howard, Kan
Eyerly, T L, 1906, Dallas, Tex (Mail returned)
Failyer, George H, M S, 1879, retired, R R 4, Manhattan, Kan
Faragher, Warren Fred, Ph D, research chemist, Universal Oil Products Co, Riverside, Ill
Garrett, A O, 1901, M A, head Dept Biology, East High School, Salt Lake City, Utah
Graham, I. D, M S, 1879, State Board Agric, Topeka, Kan
Harman, Mary T, Ph D, 1912, prof zoology, K S A C, Manhattan, Kan.
Harnly, Henry J, Ph D,, 1893, prof biology, McPherson, Col, McPherson, Kan
Harshbarger, William A, Sc D, 1903, prof mathematics, Washburn Col., Topeka, Kan
Havenhill, L D, Ph C, 1904, dean School Pharmacy, U of K, Lawrence, Kan
Haworth, Erasmus, Ph D, 1882, U of K, Lawrence, Kan
Keller, W H, A B, 1898, late prof mathematics, K S T C, Emporia, Kan Deceased
Knaus, Warren M, D Sc, 1882, entomologist, editor "Democrat Opinion", Mc Pherson, Kan
McWharf, J M, M D, 1902, 715 Princeton St, Ottawa, Kan
Meeker, Grace R, A B, 1899, city librarian, Ottawa, Kan
Menninger C F, M D, 1903, 1407 West 10 h St or R 4, Topeka, Kan
Miller, Ephraim, Ph D, 1873, 558 North Lakes Ave, Pasadena, Cal (Prof emeritus mathematics and astronomy, U of K)
Nissen, A M, A. B, 1888, farmer, Wetmore, Kan
Peace, Larry M, 1904, West Ninth St, Lawrence, Kan
Robertson, W R B., Ph D, 1905,, K. S A C, Manhattan, Kan
Reagan, Albert B, Ph D., 1904, Indian Field Service, Ouray, Utah
Sayre, Lucius E, Ph M., 1885, late dean School of Pharmacy, U of K, Lawrence, Kan Deceased
Schaffner, John H, M S, 1903, research prof botany, Ohio State Univ, Columbus, Ohio
Scheffer, Theodore, M A, 1903, assoc biologist, U S Biological Survey, Puyallup, Wash
Shirk, J. A. G., 1904, prof mathematics, K S T C, Pittsburg, Kan
Shelley, Edwin Taylor, M D, 1892, Atchison, Kan
Smith, Alva J, 1892, consulting eng, 810 Boylston St, Pasadena, Cal
Smyth, Lumina C R, Ph D, 1902, 235 Acton Road, Columbus, Ohio
Sterling, Charles M, A. B, 1904, assoc prof botany and pharmacogonsy, U of K, Lawrence, Kan
Sternberg, Charles H, M A, 1896, 4046 Arizona St., San Diego, Cal
Walker, P F, Ph D., 1905 late dean School Engng, U of K., Lawrence, Kan Deceased
Ward, Milan L, D. D., Late prof mathematics (emeritus), Ottawa Univ., Ottawa, Kan Deceased.
Welin, John Eric, D. Sc, 1889, prof chemistry, Bethany Col, Lindsborg, Kan.
Willard, Julius T., D. Sc, 1883, vice-pres. and dean Div General Science, K S A C, Manhattan, Kan.
White, E. A., M. A, 1904, prof chemistry, U of K., Lawrence, Kan.
Wooster, Lyman C., Ph D., 1889, prof biology and geology, K S T C, Emporia, Kan.
Yates, J. A., M. S 1898, prof chemistry and physics, K. S T C., Pittsburg, Kan,

ANNUAL MEMBERS

The list includes the names of those who have been members at any time during the period 1922-1928. Members paid up for 1928 are indicated by an asterisk*. The year given is that of election to membership. If two years are given, the second signifies re-election.

*Ackert, James Edward, Ph D., 1919, prof zoology and parasitologist, K. S A. C., Manhattan, Kan
*Ahlborn, Margaret, M S, 1928, assoc. prof. food economics and nutrition, K S. A. C, Manhattan, Kan
*Albertson, F. W, B S, 1928, assoc prof. agric., Hays, Kan.
Anderson, Forest N, 1918, 311 South Fortieth St., Philadelphia, Pa.
Anderson, B. M, 1925, Animal Husb Dept, K S A C, Manhattan, Kan.
*Albright, Penrose S, B S, 1926, asst prof physics and chemistry, Southwestern Col., Winfield, Kan. (2405 Chamberlain Ave, Madison, Wis.
Alter, Dinsmore, prof. English, U of K, Lawrence, Kan.
Allen, Bennet M, Ph D., 1913, prof zoology, Southern Branch Univ. California, Los Angeles, Cal
*Allen, Fred W Jr, M A, 1927, 748 Osage Ave., Kansas City, Kan.
Angulo, A W., Ph D, 1925, head Tech Lab, Wister Inst, 36th and Woodland Ave, Philedelphia, Pa.
*Ayres, H. D., 1928, Univ Wichita, Wichita, Kan
*Baker, H. G, M, A, 1926, assoc prof biology, Southwestern Col, Winfield, Kan
Baker, Lillian, M A, 1925, prof clothing and textiles, K S A C, Manhattan, Kan
Balch, W. B, 1922, asst. prof horticulture, K S A C, Manhattan, Kan
*Bartlett, Walter E., M D, 1922, physician, Belle Plaine, Kan.
*Barnett, R J, M S, 1922, prof. horticulture, K S. A. C, Manhattan, Kan
*Bennett, James L., M A, 1928, prof physics, Ottawa Univ, Ottawa, Kan
*Berry, Sr., M. Sebastian, A. B, 1911, Supt Schools, St. Paul, Kan
*Bengston, Linus, 1924, chemistry, Bethany Col, Lindsborg, Kan
Blair, J. A, 1923, McPherson Col. McPherson, Kan
*Blickenstoff, Paul, 1928, 804 14th St, Narna, Idaho
*Boone, George N, 1928, McPherson Col, McPherson, Kan.
*Borman, Ina M, B. S., 1928, supervisor science, K S. T. C., Emporia, Kan
*Bowman, J L., 1928, McPherson Col., McPherson, Kan.
Bradley, J H., 1923, Russell, Kan. Deceased
*Branch, Hazel E., Ph D, 1924, prof zoology, Wichita Univ., Wichita, Kan
Bretnall, George H., 1922, Baker Univ., Baldwin, Kan (Present address, 1900 W. Jackson St, Muncie, Ind)
*Brewster, Ray Q, Ph D, 1919, prof chemistry, U. of K., Lawrence, Kan
*Brinkley, J R., M D., 1923, physician, Milford, Kan.
*Britton, Wiley, 1923, 4 Mill St., Kansas City, Mo
Brooks, Charles H., B. S., 1928, instr. corres study, Hays, Kan
Brown, Alice L., 1921, Harlem Hosp. Lab., Bellevue and Allied Hospitals, New York, N. Y.
*Brunson, A. M., Ph. D., 1928, assoc agronomist, U. S. Dept. Agric., K S. A, C, Manhattan, Kan.
*Bryson, Harry R, M. S, 1928, instr. entomology, K. S. A. C, Manhattan, Kan
Burgin, William, 1925, McPherson Col., McPherson, Kan
Burt, Mrs. Mae Danhiem, B. S., 1925, Dept. Zoology, Univ Mich., Ann Arbor, Mich.
*Burt, Roy A, B S., 1923, geologist, 738 Board of Trade, Kansas City, Mo.
*Bushnell, Leland D., Ph D., 1908, prof. and head Bacteriology Dept., K S. A. C., Manhattan, Kan.
*Call, L. E., M. S., 1922, dean Div. Agric, director Agric. Exper. Station K. S. A. C, Manhattan, Kan
*Chaney, Margaret, Ph. D., 1928, prof. food economics and nutrition, K. S. A. C., Manhattan, Kan.
*Carpenter, A C., president Lesh Oil Co., Ottawa, Kan.
*Challans, Joanna Seiler, A. B., 1928, grad. research asst. zoology, K. S. A. C., Manhattan, Kan.

Charles, Grace M , 1918, 461 Park Ave., River Forest, Ill.
Cheatum, Elmer, M. S , 1922, Dept Zoology, Southern Methodist Unv , Dallas, Tex
*Clay, G. Harry, B. S , 1826, chemical eng., 420 West 59th St., Kansas City, Mo
Cloyd, Ann e G., B. S , 1924, 1754 North Holyoke Ave , Wichita, Kan.
*Coghill, George E., 1918, prof. anatomy, Wister Institute of Anatomy and Biology, Philadelphia, Pa
Collins, J. H , 1923, Hays, Kan., (Mail returned.)
Colin, E C , 1923, 509 East 62nd St., Chicago, Ill.
Converse, E. C , 1922, Manhattan, Kan Deceased.
*Cook, G. S , A B , 1922, Luray, Kan
Cooley, Robert A , B S , 1910, Head Dept Entomology, Montana State Col , Bozeman, Mont
*Coonfield, Ben R , M. S., 1927, Austin Teaching Fellow Zoology, Harvard Univ., Cambridge, Mass
*Cowles, Iva F , B. S , 1928, assoc prof clothing and textiles, K S. A C., Manhattan, Kan.
Cragoe, E J , 1925, Baker Univ., Baldwin, Kan.
Crawford, Mrs Naomi Zimmerman, 1925, 724 Kearney St , Manhattan, Kan
*Crow, H. Ernest, A M , 1926, prof biology, Friends Univ , Wichita, Kan
Danheim, Bertha, L , M S , 1919, Township High School and Junior Col , LaSalle, Ill
*Davidson, Arthur W , Ph. D , 1927, assoc prof chemistry, U of K , Lawrence, Kan.
Davis, F. B , 1923, no address
Davis, Charles D , B S , 1926, asst prof agronomy, K. S A. C , Manhattan, Kan.
Davis, Edgar W , M. S , 1923, asst. entomologist, box 342, Richfield, Utah.
*Dean, George A , M S 1912, head Dept Entomology, K S A C , Manhattan, Kan.
Deel, Samuel Asher, Ph. B., 1913, Baker Univ., Baldwin, Kan.
*DeForest, Howard, Ph D , 1921, Dept Botany, Southern Branch Univ. California, Los Angeles, Cal.
*DeLand, Maude Sayers, M. D., 1928, physician, State Hospital, Topeka, Kan
*Dellinger, Orris P , Ph D ,, 1909, prof. biology, K S T. C , Pittsburg, Kan.
Dobbs, Jean S., 1925, asst prof. home economics, K S A. C , Manhattan, Kan.
*Doell, J H , M. A , 1925, prof. biology, Bethel Col , Newton, Kan.
Doubt, Sarah L , Ph D , 1923, prof botany, Washburn Col , Topeka, Kan.
*Douglass, J R., M. S , 1928, asst. entomologist, U S. Bureau Entomology, Estancia, N M.
*Dowd, Dorothea R , M. S., 1928,, instr. zoology, K S. A. C , Manhatan, Kan.
Dunton, Lela E., 1926, K. S A. C , Manhattan, Kan (Mail returned.)
Eikenberry, W. L., 1922, Pennsylvania State Col., State College, Pa. (Mail returned.)
*Edgington, Orland, B S , 1928, science teacher, Almena High School, Almena, Kan.
*Eldridge, Seba, Ph D , 1928, assoc. prof. sociology, U of K , Lawrence, Kan
Elsey, Howard N., Ph D , 1919, research chemist, Westinghouse Electric Mfg. Co., E. Pittsburgh, Pa.
Emery, G., 1920, Missouri State Teach Col., Cape Girardeau, Mo
Emery, W. T , 1926, High School, Wichita, Kan.
Englund, Eric, U. S. Dept Agric , Washington, D. C
Ericson, Herman C., 1921, last address, Lawrence, Kan.
Evans, H. P., 1923, K S. T C., Pittsburg, Kan. (Mail returned)
*Evans, Neal E., B. S., 1926, instr. Junior High School, 903 Houston St., Manhattan, Kan.
Fackler, H. L., 1918, last address, Knoxville, Tenn.
*Farrell, F. D., B. S., 1824, president, K. S. A. C., Manhattan, Kan.
Fay, Arthur, M. S , 1923, assoc. prof. bacteriology, K. S. A. C., Manhattan, Kan.
Finlayson, John D., LL. D., 1926, chancellor, Univ Tulsa, Tusla, Okla.
Fleenor, Frank L., 1923, Joilet Twp. H. S., Joilet, Ill.
*Fletcher, Worth A., Ph. D., 1928, assoc prof. chemistry, Wichita Univ., Wichita, Kan.

*Foster, Martha E., M S., 1925, instr biology, Tulsa High School, Tulsa, Okla.
*Friesen, Abraham, M A, 1928, prof chemistry, Bethel Col., Newton, Kan
*Ford, Helen, Ph D, 1928, head Dept. Child Welfare and Eugenics, K. S. A. C., Manhattan, Kan
Fruse, A P, 1925, no address.
*Gates, F C, Ph D, 1922, prof. botany, K. S A C., Manhattan, Kan.
*Garanson, Clifford E, B. S., 1927, Dwight, Kan
*Gloyd, Howard K, B. S, 1922, instr zoology, K. S A C, Manhattan, Kan
*Goldsmith, William M, Ph D, 1924, prof biology, Southwestern Col, Winfield, Kan
Green, R M, 1922, prof agric conomics, K S A C, Manhattan, Kan
*Greeder, Herman, D. V M, 1928, 720 South Roosevelt, Wichita, Kan.
*Grimes, Waldo E., Ph D, 1925, head Dept. Agricultural Economics, K. S A C, Manhattan, Kan
Groening, A A, 1924, Univ Colorado, Boulder, Col, (Mail returned)
Groesbeck, Arthur, B S, 1922, United Light and Power Co, Manhattan, Kan
Gunns, C. A, 1924, tecnician, Zoology Dept, K S A C, Manhattan, Kan
Gustafson, C E., A B, 1924, instr Manual Training High School, 109 West 61st St, Kansas City, Mo
*Gosselin, Charles J, A B, 1928, Expt Lab, New Orleans Ref Co, Sellars, La
*Gordon, W. E, Ph D, 1928, physics and astronomy, K S T C, Hays, Kan
*Hafenrichter, A L, Ph D, 1928, prof. botany, Baker Univ, Baldwin, Kan
Hall, Clifford J, 1922, instr High School, Emporia, Kan
Hall, E Raymond, Ph D, 1923, curator mammals Museum Vertebrate Zoology, Univ California, Berkeley, Cal
Hamilton, J O, Ph D., 1919, prof physics, K S A C, Manhattan Kan
*Harris, C. L, Ph M, 1928, attorney-at-law Box 1088, Eldorado, Kan
*Hartman, Hugh E, B S, 1928, test eng, 258 North Martinson Ave, Wichita, Kan
Hay, Louise, 1923, Augusta, Kan (Mail returned)
Hayes, William P, 1918, asst prof entomology, Univ Illinois, Champaign, Ill
*Henning, C W, B S, 1928, science teacher High School, Stilwell, Kan.
*Henry, Edwin R, B S, 1927, Dept Psychology, Ohio State Univ, Columbus, Ohio
*Herrick, Earl H., M S, 1927, Austin Teaching Fellow, Zoology Dept, Harvard Univ, Cambridge, Mass
*Hershey, J Willard, Ph D, 1920, prof chemistry, McPherson Col, McPherson, Kan.
*Hertzler, Arthur E, M D, Ph D, LL D, 1928, prof surgery, Univ Kansas Medical School, head surgeon Halstead Hosp, Halstead, Kan
*Hesse, Mrs Katherine, M S, 1926, asst prof clothing and textiles, K S A C, Manhattan, Kan
*Hill, Robert T., 1928, B S., grad asst. zoology, K S A C., Manhattan, Kan
Hisaw, Fred L, 1921, asst prof zoology, Univ Wisconsin, Madison, Wis
Hirsh, Rudolph, B S, 1918, chemist, Ridenour Baker Grocery Co, 24 East Concordia, Kansas City, Mo
*Hoard, Earl C., 1928, Kingsdown, Kan.
*Hodger, Joseph M, B. S., 1928, technician, Dupray Lab, Hutchinson Kan
Hoffman, William E., 1920 instr, Canton Christian Col, Canton, China
*Holton High School, head Science Dept, 1928, Holton, Kan
*Horn, Elsa, M S., 1928, instr. botany, K. S A C, Manhattan, Kan
*Horton, John R., B S, 1927, assoc entomologist, U S Dept Agric, 126 South Minn. Ave., Wichita, Kan
Hughbanks, Leroy, 1914, minister Anthony, Kan.
Hughes, J S, 1926, prof chemistry, K S A. C, Manhattan, Kan.
*Humphrey, Irwin, M. S., research chemist, Hercules Pwd. Co, Kennel, N. J.
*Hungerford, H. B., Ph D., 1920, head Dept Entomology, U. of K, Lawrence, Kan
Hunter, W. S., Ph D, 1919, prof psychology, Clark Univ., Worcester, Mass
*Ibsen, Heman L., Ph D, 1922, prof genetics, Animal Husb. Dept., K S A. C., Manhattan, Kan.
*Jardine, W. M., Ph. D, 1919, sec. U. S. Dept. Agric., Washington, D. C.
*Jewell, Minna E., Ph. D, 1925, asst prof. zoology, K S. A C., Manhattan, Kan

*Johnson, George E., Ph. D, 1925, assoc prof. zoology, mammalogist Agric Exper. Sta., Manhattan, Kan.
Johnson, Charles E., prof State Col. Forestry, Syracuse, N. Y
*Johnson, C. G. Harry, M. A., 1928, asst. prof chemistry, Colorado Agric Col Fort Collins, Col.
Johnson, E. J., instr zoology, High School, Ft. Collins, Col. (Mail returned.)
*Johnston, C. O., M. S, 1928, asst plant pathologist, K. S A C., Manhattan, Kan
Jones, Ethel Ann, A M, 1924, instr chemistry, U of K., Lawrence, Kan.
*Jones, William E, B S, 1298, principal Junior High School, Garden City, Kan.
*Jones, F B, D V S, 1928, veterinarian, 517 Leavenworth St., Manhattan, Kan
*Justin, Margaret M, Ph D, 1925, 1928, dean Div Home Economics, K. S. A C, Manhattan, Kan
Kelly, E G, Ph D, 1921, prof entomology, K S A C., Manhattan, Kan
Kelley, F J 1919, U of K, Lawrence, Kan
Kester, F. E, 1927, prof physics, U of K, Lawrence, Kan
*King, Herbert H, Ph D., 1909, prof and head Chemistry Dept, K S A C, Manhattan, Kan
*Kitchen, Mary E, B S., 1924, R R 1, Box 38A, Larned, Kan
*Kramer, Martha, Ph D, 1925, prof food economics and nutrition, K S A C., Manhattan, Kan
Krull, Wendell, 1926, Elmhurst Col, Elmhurst, Ill
Krumm, Martha M, Ph D, 1925, prof food economics and nutrition, K S A C Manhattan, Kan
Laferne, B. W., B S, 1926, student, Western Reserve Medical School, Cleveland, Ohio
Laing, H R, 1920, 112 Ferman Ave, Milan, Mich
Laird, P. E, M A, 1923, head Dept Chemistry, Oklahoma Teachers Col, Durant, Okla
Langworthy, Asher E, 1922, State House, Topeka, Kan
*Larson, Mary E, A. M, 1925, assoc prof zoology, U of K, Lawrence, Kan.
*Larson, Iva, B A., 1928, asst Genetics, K S A C, Manhattan, Kan
Lash, Mendel E, B. S, 1926, Nebraska State Normal School, Chadron Neb
*Latimer, Homer B, Ph D, 1928, prof. anatomy, U of K, Lawrence, Kan
Latshaw, W L, 1923, assoc prof chemistry, K S A C, Manhattan, Kan.
*Lawson, Paul B, Ph D, 1919, prof entomology, U of K, Lawrence, Kan
*Lehman, Roy P, A B, 1928, geologist, Sinclair Oil Co, Tulsa, Okla.
*Lindahl, Glen W, B S, 1928, supt schools, Munden, Kan
*Lindley, E. H, Ph D, LL D, 1923, chancellor, U of K, Lawrence, Kan
*Lindsdale, Jean M, Ph D, 1928, research assoc California Museum Vertebrate Zoology, Univ. California, Berkeley Cal
Lippincott, Wm A, Ph D, prof poultry husbandry, Col of Agric, Univ California, Berkeley, Cal
Lough, Mrs Orpha Maust, M S, 1926, Apt C 24, 540 West 123rd St, New York, N Y
Lumb, John W, D. V M, extension veterinarian, K S A C., Manhattan, Kan
*Lyon, Eric, M S, 1926, assoc prof. physics, K. S. A C, Manhattan, Kan
McCampbell, C W, 1922 prof animal husbandry, K S A C, Manhattan, Kan.
McClelland, Ray, 1922, Highland, Kan. Deceased
*McColloch, J W., M S., 1911, prof entomology, K. S. A C, Manhattan, Kan
*McDonald, Clinton C, Ph D., 1928, prof botany, Wichita Univ, Wichita, Kan
*McKinley, Lloyd, 1928, Wichita Univ, Wichita, Kan.
*McMasters, Belle M., B. S, 1928, student, K S T. C., 923 Market St., Emporia, Kan.
Marlatt, F. A., 1920, 344 North 16th St, Manhattan, Kan
Matthews. W H., 1920, K S T C, Pittsburg, Kan.
*Maus, Pearl M, M S., Auburn, Kan.
*Melchers, Leo Edward, M. S., 1918, head Dept. Botany and Plant Pathology, K. S A. C., Manhattan, Kan.
*Menninger, Karl A., M. D, 1910 physician, Mulvane Bldg, Topeka, Kan.
Merrill, J. H., 1918, Raynham, Mass.
Meyer, John J., 1924, Kansas Wesleyan Col., Salina, Kan.

*Michner, John M., M. S, 1925, instr., chemistry, Wichita High School, Wichita, Kan.
*Miller, A W., M. S., 1928, instr. chemistry, Hutchinson Junior Col., Hutchinson, Kan.
*Miller, Edwin Cyrus, Ph. D., 1918, prof. botany, K S. A. C., Manhattan, Kan.
Miller, Lois, 1926, instr High School, Winfield, Kan. (Mail returned)
*Miller, R. F., Ph. D., 1928, prof physics, Col. Emporia, Emporia, Kan
Mitchell, U. G, Ph D, 1926, prof mathematics, U of K, Lawrence, Kan.
Mix, Arthur Jackson, Ph D, 1918, prof. botany, U. of K, Lawrence, Kan
*Moore, Fleming G., Ph. D, 1927, prof physics, Washburn Col, Topeka, Kan.
*Moore, Raymond C, Ph. D., 1918, state geologist, professor geology, U. of K., Lawrence, Kansas
*Moore, Roy, 1928, rodent control, U. S. Biological Survey, Extension Div., K. S. A. C., Manhattan, Kan
Morris, Charles S., 1923, Manchester Col., N Manchester, Ind
*Morrison, Beulah May, Ph D, 1928, asst prof psychology, U of K, Lawrence,
Murray, Mrs. J. W., 1913, last address, 504 Louisiana St., Lawrence, Kan.
*Nabours, R. K, Ph. D, 1910, prof and head Zoology Dept., K S A C, Manhattan, Kan.
Nelson, C. F, 1923, last address, Lawrence, Kan
Newman, P. J, 1922, 914 Leavenworth St., Manhattan, Kan
*Nininger, H H, 1921, McPherson Col, McPherson, Kan.
*Nolf, L. O., B S., 1928, research asst zoology, K S A. C, Manhattan, Kan
*Oman, A E,, B S., M. F, 1928, asst. biologist, U. S Biological Survey, Extension Div., K. S. A. C., Manhattan, Kan.
Oncley, Lawrence, 1926, Southwestern Col., Winfield, Kan.
O'Roke, Earl, 1917, Dept Zoology, Univ California, Berkeley, Cal.
*Oxnard, H W, B. S, 1928, asst eng., A. T. & S. F. R R Topeka, Kan
*Painter, Reginald, Ph. D., 1927, asst. prof. entomology, K. S A C., Manhattan, Kan.
*Pankratz, David S, M. A., 1928, instr anatomy, U. of K, Lawrence, Kan.
*Parker, J. H., Ph D, 1918, prof. crop improvement, Dept Agronomy, K S A. C., Manhattan, Kan.
Parker, Ralph L., Ph. D., 1926, assoc prof entomology and apiculture, state apiarist, K. S. A. C., Manhattan, Kan.
*Payne, Nellie M., Ph D, 1920, scientific staff, Biological Abstracts, Zoological Lab., 38th and Woodlawn Ave, Philadelphia, Pa
Perkins, Alfred T., 1925, asst. prof. chemistry, K. S. A C., Manhattan, Kan.
*Perrine, Irving, Ph. D, 1921, oil operator, geologist, 1619-21 Petroleum Bldg., Oklahoma City, Okla.
*Peterson, J C, Ph. D., 1919, prof education, K. S A. C., Manhattan, Kan
Phillips, J. M., M A., 1922, last address, Wichita, Kan.
*Pittman, Martha S., prof food economics and nutrition, K. S. A. C., Manhattan, Kan.
Pommerenke, Wesley T., Ph. D., 1923, instr. physiology, Univ. of Wisconsin, Madison, Wis.
Posey, Chesley J., 1925, prof. geology, U. of K., Lawrence, Kan.
*Potter, Isabel, M. S., 1926, instr. biology, Winthrop Col, Rock Hill, S. C.
*Prince, S. Fred, 1928, biological artist, K. S. A. C., Manhattan, Kan.
Randall, G. R., 1923, Marysville, Kan. (Mail returned.)
*Rankin, Roy, M. A., 1919, prof. chemistry and bacteriology, K. S. T. C., Hays, Kan.
Rayburn, G. E., 1919, prof. physics, K. S. A. C., Manhattan, Kan.
*Readio, Philip A., M. S., 1928, asst. prof. entomology, U of K., Lawrence, Kan.
Reed, Mrs. Bessie T., 1918, Univ. Chicago Med. School, Chicago, Ill. (Mail returned.)
Reed, C. I., 1920, Univ. Chicago Med. School, Chicago, Ill.
*Reinisch, E. F. A., 1917, landscape artist, City Park Dept., City Hall, Topeka, Kan.
Rener, Alice, 1924, 503 South Millwood Ave., Wichita, Kan.
Rice, M. E., 1925, prof. physics, U. of K., Lawrence, Kan.

Robb, Vance N., 1921, McPherson Col., McPherson, Kan.
Roofe, Paul G., 1926, prof. Univ. Chicago, Chicago, Ill.
Rosenberry, Eulalia E, 1909, K. S T. C., Pittsburg, Kan.
*Rouse, J E., M. S., 1928, prof. agric., K S. T. C., Hays, Kan
*Royer, W. D., A B., 1927, instr biology, High School, Wichita, Kan.
Ruby, Pearl E., 1925, last address, K. S A. C., Manhattan, Kan.
Rude, C. S, 1918, asst. entomologist, Texas Exper Sta, State College, Texas.
Ruppenthal, Harold F, 1923, Chemical Copper Co., Hurley, N. M.
*Russom, Vaughn W., A B, 1928, field geologist, Box 543, Wichita, Kan.
*Rust, Mrs Lucille, M. S, 1928, assoc prof. education, K. S A. C, Manhattan, Kan.
*Sager, Howard W, B S, 1928, supt. High School, Montrose, Kan
*Salmon, S C., M S, 1926, prof farm crops, K S A. C, Manhattan, Kan.
*Sarles, William B, M S, insti bacteriology, K. S A C, Manhattan, Kan.
*Sarrac no, John, 1928, K S. T C, Emporia, Kan (Valdez, Col)
*Sayre, Claude E, Ph D, 1924, clergyman, 448 N Topeka Ave, Wichita, Kan
Schmidt, M M., 1914, last address, Summerfield, Kan
Schneider, Carl 1924, prof Wittenberg Col, Springfield, Ohio
*Schoewe, Walter H, Ph D, 1925, assoc prof geology, U of K, Lawrence, Kan.
*Schovee, Joseph C, 1928, asst. eng., A. T. & S F R. R, 1235 Boswell Ave, Topeka, Kan.
*Schumann, Margaret, M A, 1922, technician, Anatomy Dept, U. of K, Lawrence, Kan.
Scott, Joseph P., 1923, assoc. prof pathology, Veterinary Div, Manhattan, Kan.
*Seaton, Roy A, M. S, 1928, dean D v Engineering, K S A C, Manhattan, Kan
*Setty, Laural R., 1928, Emporia, Kan
Setzler, Horace, Ph D., 1923, Coffeyville, Kan
*Sewell, M C, Ph D., 1928, assoc prof soils, Agronomy Dept., K S A. C, Manhattan, Kan
*Shaad, G C, 1921, dean Engineering School, U of K., Lawrence, Kan.
Shalton, George W, 1923, no address
*Shaw, Ruth C, M A, 1928, asst instr zoology, U of K, Lawrence, Kan.
Sherwood, Noble P, Ph D, M D, 1917, prof. bacteriology, U of K, Lawrence, Kan
Shewman, W D, 1920, K S T C, Hays, Kan (Mail returned)
Shull, C. A, Ph D, 1917, prof plant physiology, Univ Chicago Chicago, Ill
*Simpkins, Dan, 1928, student, K S T C, Emporia, Kansas (Reading, Kan.)
Skinner, W H, 1923, Bethany Col, Lindsborg, Kan
Slater, Leon B, 1926, Wichita Univ., Wichita, Kan (Mail returned.)
*Smith, Roger C., Ph. D, 1921, Service Technique, Dept Agric, Port-au-Prince, Haiti.
*Snodgrass, Ethel, M A, 1928, prof home economics, K S T C, Hays, Kan.
*Spencer, D H, 1925, Pharmacy Dept., U. of K, Lawrence, Kan
*Sperry, Arthur B., B S, 1917, 1922, prof. geology, K S A C, Manhattan, Kan.
*Stanley, George B, M D., Ph. D., 1928, physic an and surgeon, Windsor Hosp, Windsor, Col
*Steen, Robert A., 1928, student, K S T. C, Emporia, Kan. (1702 W. 15th St)
*Stein, Fred W., 1928, president Steinite Radio Co, Atchison, Kan
*Sternberg, George F, 1928, field veterbrae paleontologist, K. S T C., Hays, Kan
Stevens, William C, 1890, head Botany Dept, U of K, Lawrence, Kan.
Stewart, Charles W, 1926, instr chemistry, High School, Winfield, Kan. (Mail returned)
Stiles, Miss Glenn, 1926, instr. botany, Wichita Univ., Wichita, Kan. (Mail returned.)
*Stoland, O O., Ph D., 1918, prof. physiology and pharmacology, U of K., Lawrence, Kan.
*Stoltz, Martha, M. S., 1928, prof. biology, Ottawa Univ, Ottawa, Kan.
Stone, J. R., 1923, Quartermaster's Office, U. S. Disciplinary Barracks, Ft. Leavenworth, Kan
Stratton, George, Ph. D., 1918, prof. chemistry, U. of K., Lawrence, Kan.
Strickland, Frank P., Ph. D., 1923, prof. education, K. S. A. C., Manhattan, Kan.

*Studt, Charles W., M. S., 1928, chief geologist, Union Gas Co., Independence, Kan.
Sutter, L. A., M. D., 1923, physician, 601 First National Bank Bldg., Wichita, Kan.
*Swanson, Arthur F., M. S., 1926, agronomist, Fort Hays Exper. Sta., Hays, Kan.
Taft, Robert, Ph. D., 1923, assoc. prof. chemistry, U. of K., Lawrence, Kan.
Tanquary, M. C., 1912, Texas Exper. Sta., State College, Texas
*Taylor, Edward H., Ph. D., 1928, assoc. prof. zoology, U. of K., Lawrence, Kan.
*Thompson, D. Ruth, M. A., 1928, prof. chemistry, Sterling Col., Sterling, Kan.
Thompson, Helen B., Ph. D., 1919, Univ. of California at Los Angeles, Los Angeles, Cal.
Titus, R. W., 1924, assoc. prof. chemistry, K. S. A. C., Manhattan, Kan.
Todd, J. E., M. A., 1907, asst. prof. geology, U. of K., Lawrence, Kan. Deceased
Tracy, Henry C., Ph. D., 1926, prof. anatomy, U. of K., Lawrence, Kan.
*Truesdell, B. W., B. S., 1923, head Science Dept., High School, (705 N. Lawrence Ave.) Wichita, Kan.
*Tucker, Ruth E., M. S., 1928, inst. food economics and nutrition, K. S. A. C.,
Vergades, V. R., 1025, last address, Clay Center, Kan.
*Wade, Joseph S., 1927, assoc. entomologist, U. S. Dept. Agric., Washington, D. C.
*Walkden, Herbert, 1928, 126 S. Minnesota Ave., Wichita, Kan.
Walker, Maurice, 1925, U. of K., 842 Tennessee St., Lawrence, Kan.
Walling, Lalie V., 1923, prof. physiology, U. of K., Lawrence, Kan.
Walls, Jones R., 1920, instr. biology, K. S. T. C., Pittsburg, Kan.
*Walters, Orville, 1928, McPherson Col., McPherson, Kan.
*Warren, Don C., Ph. D., 1925, assoc. poultry husbandry, K. S. A. C., Manhattan, Kan.
*Watson, G. N., Ph. C., B. S., 1928, manager, Watson Lab., Independence, Kan.
Weber, Arthur D., 1925, Univ. Nebraska, Lincoln, Neb.
*Weber, Clement, Catholic priest, Clay Center, Kan.
*Wedel, Elvira, Ph. D., 1927, asst. prof. chemistry, Bethel Col., Newton, Kan.
*Weeks, Elvira, Ph. D., 1927, asst. prof. chemistry, U. of K., Lawrence, Kan.
*Weidlenin, Edward Ray, Sc. D., 1921, director Mellon Inst. Industrial Research, Pittsburgh, Pa.
*Weidlein, W. D., B. S., 1928, prof. physics, Hays, Kan.
Wells, J. R., 1920, K. S. T. C., Pittsburg, Kan.
*Whitcomb, S. L., A. M., Litt. D., 1826, prof. English, U. of K., Lawrence, Kan.
Williams, C. C., C. E., 1917, prof. engng., U. of K., Lawrence, Kan.
*Wilson, William B., Sc. D., 1903, dean, head Dept. Biology, Ottawa Univ., Ottawa, Kan.
*Wimmer, Edward J., Ph. D., 1928, asst. prof. zoology, K. S. A. C., Manhattan, Kan.
Wood, A. G., 1924, Baker Univ., Baldwin, Kan.
Woodruff, Sybil, 1027, Home Economics Dept., U. of K., Lawrence, Kan.
Woodward, Parke H., M. D., 1925, interne, Denver General Hosp., Denver, Col.
*Wooster, L. D., Ph. M., 1926, prof. biological sciences, K. S. T. C., Hays, Kan.
*Worden, Alice R., 1928, student, K. S. T. C., Emporia, Kan. (905 N. Jefferson St., Wellington, Kan.)
*Wunsch, W. A., B. S., 1927, county extension agent, Carlsbad, N. M.
*Yoder, J. J., LL. D., 1926, prof. sociology, McPherson Col., McPherson, Kan.
Young, C. M., B. S., E. M., 1920, prof. mining engng., U. of K., Lawrence, Kan.

FIFTY-FOURTH ANNUAL SESSION

KANSAS ACADEMY OF SCIENCE

Manhattan, February 17 and 18, 1922

OFFICERS FOR 1921-1922

Roy Rankin, Hays ---------- President
R. K. Nabours, Manhattan ---------- First Vice-President
W. R. B. Robertson, Lawrence ---------- Second Vice-President
L. D. Havenhill, Lawrence ---------- Treasurer
E. A. White Lawrence ---------- Secretary
Mary T. Harman, Frank U. G. Agrelius, W. J. Baumgartner and W. A. Harshbarger, Additional Members of the Executive Council

PROGRAM

Friday, February 17, 1922

10:30 a. m. Business. Reading of Papers.
2:00 p. m. Business. Reading of Papers.
8:00 p. m. Lecture by H. P. Cady. A demonstration of some of the phenomena of radio activity.

Saturday, February 18, 1922

9:00 a. m. Business. Reading of Papers.

PAPERS SUBMITTED FOR THE FIFTY-FOURTH SESSION

(Reference to place of publication is given in parentheses when supplied by the author. Changes in authorship, title, or material included, are not given here.—EDITOR.)

1. Non alcoholic Beverage Industry and its Connection with Fruit-Flavors. L. E. Sayre.
2. Feeding Habits of Moles. F. L. Hisaw.
3. Observations on the Burrowing Habits of Moles. F. L. Hisaw.
4. A Banyan Tree (Kabir Vad), Narboda, India. H. J. Harnly.
5. Plant Diseases in Kansas in 1921. L. E. Melchers.
6. Botanical Notes for 1921. F. U. G. Agrelius.
7. The Meal Snout Moth (Pyralis costalis) as an Alfalfa Hay Pest. Nellie M. Payne.
   (Jour. Econ. Ent., Vol. 18, pp. 224-227, 1925)
8. Rare Coleoptera Collected by the McPherson Scientific Expedition in July and August, 1921. W. Knaus.
9. The Preservation of Natural Areas in Kansas. J. W. McColloch.
   (Naturalist's Guide to America, 1925)
10. Experiments upon the Transplantation of Thyroid and Pituitary Glands of Frogs into Tadpoles. B. M. Allen.
11. The Neuroptera of Kansas. R. C. Smith.
    (Bull. Brooklyn Ent. Soc., Vol. 20, pp. 165-171, 1925)
12. The Economic Value of By Product Foods. E. H. S. Bailey.
13. Notes on the Wheat Foot Rot Disease in Kansas. (Lantern slides) L. E. Melchers.
14. Nutritive Properties of Sorghum Seed in Relation to Agronomic Value and improvement of Varieties. J. S. Hughes and J. H. Parker.

15. Crop Improvement in Kansas. J. H. Parker.
16. Importance of Plant Succession in Pasture Management. R. L. Hensel.
17. Crop Sequence of Sorghums M C Sewell
18. The Origin of the Notochord in the Chick. Mary T Harman. (Anat. Rec, Vol 23, No 7)
19. Star Thistle (Centaurea picris Pall). A New Weed in Kansas. F. C. Gates. (Published in this volume of the Transactions)
20. Recent Development in Hookworm Disease in Trinidad, British West Indies (Illustrated) J E Ackert.
21. Raising Experimental Chickens in Confinement. C. A Herrick. (Jour Agr Res, Vol 25, pp 451-455)
22. Dipping Refractometer Tables for Solution of Alcohol, Hydrochloric Acid and Acetic Acid Howard McKee Elsey and George Lynn
23. The Modification of the Separation of the Members of the Aluminum Group. Hamilton P Cady and Arthur W. Davidson
24. A convenient Type of Lecture Electroscope for Use in a Projecting Lantern Howard McKee Elsey
25. Inheritence in Grouse Locust, Apotettix eurycephalus, Hancock. Robert K Nabours. (Kans Tech Bull 17, pp 1-231, 1925)
26. The Preparation of Aromatic Mustard Oils F B. Dains, R Q Brewster, C. P Olander (Jour Kans Univ. Sci Bull, Vol 13, No. 10, pp. 1-14)
27. A New Thiazol and Thiazane Synthesis F B Dains, R Q Brewster, W C. Thompson (Jour Amer. Chem Soc, Vol 44, 2037-43, 1922)
28. Heat as a Factor in Producing Abnormalities During Incubation in the Chick Mary T Harman (Published in this volume of the Transactions)

MINUTES OF THE FIFTY-FOURTH ANNUAL MEETING

EDITOR'S NOTE The minutes have been edited and where possible have been condensed

The fifty-fourth annual meeting of the Kansas Academy of Science was held at Manhattan, February 17 and 18, 1922. The meeting was called to order by the president, Roy Rankin, at 10:30 Friday morning. The minutes of the fifty-third meeting were read and approved, after which the president appointed the following committees:

Program: Agrelius, Nabours, Harnly.
Resolutions: Nininger, Knaus, Dains.
Auditing: Raburn, McKittrick, Parker.
Membership: White, Harshbarger, Agrelius, Nininger, Bushnell.
Publishing: Willard, Dains.
Press: Smith, Sayre, Wooster.
Legislature: Nabours, Allen, Harman.
Research: Cady, Hughes, Thompson, Hungerford.
Parks: McColloch, Dellinger, Hensel, Meeker.
Nominating: Dellinger, Melchers, Elsey.

The nominating committee reported the following nominations: President, R K. Nabours; first vice-president, H. P. Cady; second vice-president, H. H. Nininger; treasurer, L. D. Havenhill; secretary, E. A. White; other members of the executive council, F. U. G. Agrelius. Roy Rankin, W. A. Harshbarger, O. P. Dellinger

The officers nominated were unanimously elected. The following were elected to life membership in the Academy: H. P. Cady, L. M.

Pease. C. M. Sterling and J. Whit Eby.

The auditing committee reported the treasurer's books correct.

The committee on resolutions expressed appreciation for the accomodations for the meeting, for the provision of visits to the various departments of the Kansas State Agricultural College, for the banquet, and also for the services of Secretary White and for the lecture by Dr. Cady.

Papers were read and discussed at all the sessions.

A meeting of the executive council was called for Saturday afternoon, February 18, 1922.

Report of the Secretary

Our exhibit cases are still scattered among the departments of the University, having been loaned by the former secretary.

The last legislature failed to appropriate any money for the Academy. For this reason it seems necessary that the secretary mention the finances of the Academy before the treasurer appears. The executive council met in Manhattan last November and discussed the financial situation. They agreed to pay from the funds already in the hands of the treasurer to the secretary for his services at the rate of five hundred dollars per year from July 1, 1921, to the date of this meeting. Two hundred and fifty dollars of this amount has been collected.

E. A. WHITE, Secretary

Report of the Treasurer

Receipts:	
Balance brought forward	$926.29
Collected in dues	69.00
Interest on Savings Deposits	32.88
Other sources	3.60
Total receipts	$1,031.77
Disbursements	$475.53
Balance on hand February 15, 1922	$556.24

L. D. HAVENHILL, Treasurer

Report of Executive Council Meeting, February 18

It was agreed that the Academy accept the proposition of Chancellor Lindley of the University of Kansas with reference to housing the Academy library.

A committee consisting of the secretary, Dains and Cady, was appointed to take up the matter of the scattered display cases belonging to the Academy.

Dr. Nabours and the secretary were appointed to visit the secretary of the State Board of Agriculture in regard to funds.

Motion that the executive council requests the State Board of Administration of Educational and Correctional Institutions to assume control of the Academy of Science and provide for its future growth and care, was made, seconded and carried.

Letter from Chancellor Lindley Regarding Academy Library

University of Kansas, Lawrence, Kansas.
February 16, 1922.

Mr. E. A. White, Secretary,
The Kansas Academy of Science,
University of Kansas.

My dear Mr. White:

By legislative enactment, the library of the Kansas Academy of Science is located at the University of Kansas. Up-to-date, the collection has been housed in a manner which has made it somewhat inaccessible for practical use by men of science. The University is now making plans for a new library building and we propose to the Kansas Academy of Science the following for the future of the library:

First: That space for the collection be set aside in one section of the stack room of the new library and that it be maintained there as a separate collection, except as may be agreed upon in the case of certain classes of material by representatives of the Kansas Academy of Science and of the University.

Second: That the University arrange the books in this space according to plans approved by the director of the University library.

Third: That desk space be made available for the secretary of the Academy in the library building, within easy reach of the Academy library.

Fourth: That the books of the collection be made available to readers in the library on the same terms as other books in the University collections.

Fifth: That the librarian of the University be the final authority on the general arrangement and classification of books of the collection, the same as if they were a part of the general University library, but that the Academy of Science retain control over the development of the collection, including exchanges, additions to books, and the like. All books, phamplets, and other materials acquired by the Kansas Academy of Science shall be stamped with the seal of the society as a mark of ownership.

These proposals are made in the belief that the Kansas Academy of Science wishes to have the widest possible use made of the material in its library. The University is very anxious, of course, to make its space as serviceable as possible to students of science.

Very sincerely yours,
E. H. LINDLEY, Chancellor

FIFTY-FIFTH ANNUAL MEETING

KANSAS ACADEMY OF SCIENCE

Lawrence, February 16 and 17, 1923

OFFICERS FOR 1922-23

R. K. Nabours, Manhattan ---------------------------------- President
H. P. Cady, Lawrence ---------------------------- First Vice-President
H. H. Nininger, McPherson ------------------ Second Vice-President
L. D. Havenhill, Lawrence ---------------------------------- Treasurer
E. A. White, Lawrence ------------------------------------- Secretary
F. U. G. Agrelius, W. A. Harshbarger, Roy Rankin, O. P. Dellinger,
Additional Members of the Executive Council

PROGRAM

Friday, February 16, 1923

10:30 a. m. Business. Reading of Papers.
1:30 p. m. Business. Reading of Papers.
6:30 p. m. Dinner.
Address by Chancellor Lindley.
Address by A. B. Carney.
Short talks by several members of the Academy.
8:00 p. m. Presidential address by Dr. R. K. Nabours: "Eugenics; the Limitations and the Promise."
(Jour of Hered Vol. 14, pp 277-288, 1923)

Saturday, February 17, 1923

8:30 a. m. Reports of Committees. Reading of Papers.
1:30 p. m. Meeting of the New Executive Council.

PAPERS SUBMITTED FOR THE FIFTY-FIFTH SESSION

1 Review of Investigat on upon the Loco Weed, Astragalus mollissimus and Oxytropus lamberti. L E. Sayre.
2 Tad-poles as an Indicator in Pharmacolog cal Standardization L. E. Sayre.
3 A Half Century of Chemical Teaching. E H S. Bailey.
4. Some Needed Reforms in the Packing of Food Products E. H S Bailey
5. Continued Archaeological Studies in the Navajo Country, Arizona A. B Reagan.
(Published in this volume of the Transactions)
6. A West Coast Indian Honeymoon. A. B. Reagan.
7. Traveling Light. A. B Reagan.
8. Additions to the List of Kansas Coleoptera. W. Knaus.
9. The S'lovined Beetle, Leonedia neomexicana Cockil in Central Kansas. W. Knaus.
10. A Projection Galvanometer for Lecture Experiment in Electro-chemistry. H. M. Elsey.
11. Revised List of the Lepidoptera of Kansas. F. F. Crevecoeur.
12 Chemistry as Evaluated by the Student. Roy Rankin.

13 A Cambrian Plant. What is it? L. C. Wooster.
14. The Scientific Method of Reasoning, vs. the Medieval. L. C. Wooster. (Teaching, Kansas State Teachers College of Emporia, 1928)
15. The Edge of a Coal Field. C. M Young.
16. Evolution. J. M. McWharf.
17. Some Aspects of Endocrinology. C. I. Reed
18 The Gray Squirrel in Trouble. Theo. H. Scheffer.
19. Biological Notes for 1922 F U G. Agrelius.
20. A Study of the Chemical Characteristics of the Connective Tissue of Clams. Helen Thompson.
21 Anaxemia C F. Nelson.
22 The Anatomy of a Two-headed Calf with a Consideration of its Possible Origin. Mary T Harman, C A Herrick, Ernest Hartman, Florence Stebbins, L F. Payne, Luella Schaumburg.
23. Additions to the Chrysomelidae of Kansas James A. Douglas. (In preparation for Jour Kan. Ent Soc)
24. The Life Stages of Some Hemerobiids Roger C Smith (Annals Ent Soc Amer Vol 6, pp. 120-148, 1923)
25. The Ecological Features of Kansas J. W McColloch.' (Naturalist's Guide to the Americas, 1926)
26. Notes on Winter Birds of McPherson and Vicinity in 1922-23. H H Nininger.
27. The Fossil Deposits of the Rancho La Brea Asphalt Beds H. H Nininger.
28 The External Anatomy of the Ventral Side of the Head of Pyralis farinalis Linn. Nellie M Payne.
29. Take-all Disease of Wheat in Kansas. R P White and L. E Melchers
30 Studies of Foot-rot of Wheat (Take-all) in Kansas. L E. Melchers.
31. In the San Juan Basin, New Mexico. Charles H. Sternberg.
32. Notes on Food Habits of Some Raptores. H. K. Gloyd.
33. Observations on Migration of Certain Nematode Larvae Bertha L Danheim. (Trans. Amer Micro. Soc, Vol 44, pp 14-23, 1925)
34. Some Effects of Nematodes on Young Chicks. C. A Herrick. Introduced by J E. Ackert (Anat. Rec., Vol 26, p 359, 1923)
35. On the Longevity of Infected Hookworm Larvae. James E. Ackert.
36. The Development of Body Movements in Relation to the Maintenance of the Visual Field. H. C Tracy
37. Pigment as an Indicator of Rates of Differentiation in Vertebrate Embryos. Hervey Faris.
38. The Use of Cerebral Anemia in Experimental Studies upon Mammalian Embryos. E. A Swenson.
39. The Development of Motor Centers in the Brain as Correlated with their Function. Ira D. Hogg. (Jour Comp. Neur, Vol 44, pp. 449-495, 1927.)
40. Rates of Differentiation in the Nervous System as Possible Factors in the Growth of Conducted Paths. Geo. E. Coghill.
41. The Bacteriophage Phenomenon L D. Bushnell.
42. Friends of Man Beneath the Sod. P. L. Gainey.
43. Bacterium pullorum as a Factor in Low Hatchibility. F. R. Beaudette.
44. Bacterial Content of Kansas Ice Cream. A. C. Fay. (*Jour.* of Dairy Science, Vol 6, pp 283-291, 1923)
45. Some Natural Gases Unusually Rich in Helium. H P. Cady.
46. On the Reactions of the Substituted Rhonanines. F. B Dains and S. P. Davis. (Kans. Univ. Sci. Bull., Vol. 15, No. 5, 1924)
47. Notes upon the Preparation of Announcement Slides. L. M. Peace.
48. Extraction of Caesium from Pollucite. Dale Puffett.
49. The Mississippi River During the Illinoian Stage of Glaciation. W. H. Schoewe. (Jour. Geol., Vol. 31, pp. 420-432, 1923)
50. Inheritance of "Red Eye" in Guinea Pigs. H. L. Ibsen and P. W. Gregory.
51. Swamp and Bog Plants; Iris versicolor L. F. C. Gates. (Torreya, Vol 24, pp. 55-57, 1924)
52. Report on the Library of the Kansas Academy of Science. E. N. Manchester.

MINUTES OF FIFTY-FIFTH ANNUAL MEETING

The fifty-fifth annual meeting of the Kansas Academy of Science was held at Lawrence, February 16 and 17, 1923. The meeting was called to order by the president, Dr. R. K. Nabours, at 10:30, Friday morning. The minutes of the fifty-fourth annual meeting were read and approved.

The following committees were appointed by the president:

1. Program: Agrelius, Rankin, Dellinger.
2. Resolutions: Agrelius, Ackert, Nininger.
3. Auditing: Rankin, Dean Thompson.
4. Membership: White, Havenhill.
5. Publishing: White, Willard, Dains, Baumgartner.
6. Press: White, Knaus, Ackert.
7. Research: Dains, Bushnell, Hungerford.
8. Parks: McCulloch, Knaus, Dellinger, Miss Meeker.
9. Nominating: Elsey, Agrelius, Welin.
10. Necrology: Dean Sayre, Knaus, Dean Willard.

The reading and discussion of papers followed.

On Friday evening, the Lawrence members gave a banquet to the visiting members and to many of the prominent citizens of Lawrence. The speakers at the banquet were Chancellor Lindley and A. B. Carney, president of the State Board of Administration. After the banquet, Dr. Nabours delivered the presidential address.

The resolutions committee presented a report expressing gratitude to the University for its hospitality, to the resident members for the banquet served, to Professor E. A. White for his continued services in spite of failure of remuneration, and to the president of the Board of Admisistration, Mr. A. B. Carney, for his interest in science.

The auditing committee reported the books of the treasurer correct.

The membership committee reported fifteen new members. Dr. H. C. Allen, Prof. J. A. G. Shirk, Prof. W. J. Baumgartner and Professor C. M. Sterling were elected life members.

Dr. E. C. Franklin, a life member, was elected an honorary member.

Professor McColloch reported the work of the Parks committee.

The nominating committee reported the following nominations: president, H. P. Cady; first vice-president, H. H. Nininger; second vice-president, J. E. Ackert; treasurer, L. D. Havenhill; secretary, E. A. White; additional members of the executive council, R. K. Nabours, W. A. Harshbarger, F. U. G. Agrelius, and J. T. Willard.

The report was accepted and the nominees elected.

A motion was made and carried requesting the executive council to appoint a committee to aid the secretary in securing new exchanges. Dr. Dains, Professor Baumgartner and Miss Harman were appointed.

The committee on resolutions suggested that the Academy take some suitable means of showing the regards of the society for Pro-

fessor Ward and Prof. W. H. Keller. Flowers and letters of greetings and good wishes, of regret at their inability to attend the meeting, and of appreciation of past interest and activity in the Academy, were sent by a special committee consisting of L. C. R. Smyth, J. T. Willard and W. J. Baumgartner.

The treasurer reported $271.89 cash on hand. This report was declared correct by the auditing committee.

The committee on publications reported that it had met in the fall of 1922, examined papers that were in the office of the secretary, and decided to publish Vol. 31 as soon as the secretary had enough material. The secretary proceeded to prepare Vol. 31 as far as possible for the state printer, but investigation showed that the laws relating to the Academy had been repealed.

Report of the Secretary

Volume 30 of the Transactions was received and sent out to the active members and to a part of our exchanges.

At the request of the president a letter was sent to all members of the American Association for the Advancement of Science who live in Kansas and who were not members of the Academy asking them to join the Academy and pay their dues through the secretary of the Academy. Many of them, as our list of new members shows, responded favorably. Others had already paid and promised to pay through the Academy next year. Seventy members of the American Association have paid their dues through the Academy for 1923.

A letter and an index to the 30 volumes of the Academy Transactions were prepared and mailed to all members as well as to all members of the state legislature. Programs of this meeting were also sent to both members and legislators.

Our library is now in charge of Director Manchester of the University Library but the secretary stills looks after our own volumes and exchanges sent out. The incoming exchanges are sent directly to the library.

The president and secretary executed and sent in to the state auditor and the former governor a request for an appropriation of $1,000 per year for two years for the secretary's salary and also a request for $500 to pay for binding and getting some of our books in condition to be used.

The financial condition of the Academy was taken up by the executive council at its meeting February 18, 1922. After discussing ways and means for obtaining funds, a committee consisting of the president and the secretary was appointed to take the matter up with the Secretary of Agriculture.

They called on this gentleman and presented the situation. He listened attentively but on account of many other demands he could give us nothing but sympathy.

The secretary was paid from the Academy's funds to July 1, 1922. Since then he has received no compensation.

The communication from Chancellor Lindley, concerning the Acad-

emy library was accepted and the secretary instructed to inform him of the acceptance.

A motion was made and carried that members presenting papers for publication, present abstracts of them, for use of the publication committee, as well as the papers.

—E. A. WHITE, Secretary

Report of the Treasurer

Expenses:

Balance brought forward from 1922	$556.64
Interest	5.00
Dues paid to treasurer	101.00
Total receipts	$662.64

Expenses

Secretary's salary to July 1, 1922	$250.00
Expenses pertaining to the office and duties of secretary	140.75
Total expenses	$390.75
Cash on hand February 16, 1923	$271.89

—L. D. HAVENHILL, Treasurer

Letter from the Secretary Regarding the Academy Library

University of Kansas, Lawrence, Kans., February 21, 1924

Chancellor E. H. Lindley,
University of Kansas.
My Dear Chancellor:

Your letter concerning the Kansas Academy of Science Library was presented to the Academy in session at Manhattan, Feb. 17, 1922.

The Academy voted to accept your proposals as mentioned in your letter and directed the executive council to take steps to turn the library over to the University in accordance with your letter.

The executive council met February 18, 1922, and directed the secretary to turn over the library to the University under the conditions mentioned in your letter.

The Academy owns eighteen plate glass exhibit cases which are now scattered among several departments of the University, one being in the front hall of the library. These cases were loaned by a former secretary to the art department for an exhibit held in the upper floor of East Ad. building but it seems they have allowed them to be scattered. It was the sentiment of the meeting at Manhattan that these cases be gotten together with our other property as soon as we have some place to put them. The secretary, Dr. Cady and Dr. Dains were appointed a committee to look after this property.

Your letter and a record of the acceptance will be published as a part of the secretary's report.

—E. A. WHITE, Secretary, Kansas Academy of Science

FIFTY-SIXTH ANNUAL MEETING

KANSAS ACADEMY OF SCIENCE

McPherson, April 4 and 5, 1924

OFFICERS FOR 1923-1924

H. P. Cady, Lawrence ---------------------------------- President
H. H. Nininger, McPherson ------------------- First Vice-President
J. E. Ackert, Manhattan --------------------- Second Vice-President
L. D. Havenhill, Lawrence ------------------------------ Treasurer
E. A. White, Lawrence ---------------------------------- Secretary
R. K. Nabours, W. A. Harshbarger, F. U. G. Agrelius, and J. T. Willard, Additional Members of the Executive Council

PROGRAM

Friday, April 4, 1924

10:30 a. m. Business. Reading of Papers.
1:30 p. m. Business. Reading of Papers.
8.00 p. m. Presidential Address by H. F. Cady: "Atomic Structure".

Saturday, April 5, 1924

8:30 a. m. Reports of Committees. Reading of Papers.
1:00 p. m. Meeting of the new Executive Council.

PAPERS SUBMITTED FOR THE FIFTY-SIXTH SESSION

1. Laborers in Science. A Retrospect. E. H S. Bailey.
2. Enough to Eat. An Economic Study. E. H. S. Bailey.
3. Ferment Like Remedial Agents. L. E. Sayre.
4. Maize and Maize Products: Sugar. L. E. Sayre.
5. Notes on the Navajo Country, Arizona. (A continuation of the 1919, 1921 and 1922 reports) Albert B. Reagan.
   (Published in th's volume of the Transactions)
6. Glacial Erratics in Shawnee, Douglas, and Johnson Counties, Kansas. Walter H. Schoewe
   (Published in this volume of the Transactions)
7. Botanical Notes for 1923. Frank Agrelius.
8. Archaeology in McPherson County. Vance N. Robb.
9. Sternberg's Expedition to the New Dinosaur Beds of San Juan County, New Mexico. Charles H. Sternberg.
10. Quantitative Measurements of Radioactivity with a Projection Electroscope. Howard M. Elsey and Ethel Ann Jones.
11. Relative Viscosity Measurements. Howard M. Elsey, C. G. H. Johnson.
12. A Note on Ground Burnut (Tribulus terrestris). L. D. Wooster.
13. Encouraging Public School Museums. L. D. Wooster.
14. The Oil Wells of Greenwood County. L. C. Wooster.
15. Some Phases of the Life History of the Pea Aphid (Macrosiphon). Edgar W. Davis.
   (Jour. Agr. Research, Vol. 33, pp. 47-57, 1926)
16. Collecting Notes, 1923. W. Knaus.
17. Life History of Cicindela. W. Knaus.
18. Strategus morman Burm. W. Knaus.

19. Some Solvent Properties of Liquid Sulphur Dioxide and Phosphoric Oxychloride. H P. Cady, Robert Taft
20. The Absolute Value of an Electrode Potential. H. P. Cady, John Barker.
21. Some Factors Influencing the Viability of the Eggs of Ascaridia pespicillum Ernest Hartman.
    (Anat. Rec., Vol 26, p. 360—Abstract)
22. Notes on the Parasites of Rabbits Bertha L Danheim
23. Are the Ascardis of Man and Pig Identical. James E. Ackert.
24 Notes on Insects of the Dogbane (Apocynum), with Observations on the Egg Laying of Chrysochus auratus (Fab) Wm E Hoffman
25. Notes on Velia watsoni Drake, with Some Addit ons to the List of Aquatic Hemiptera of Kansas Wm E Hoffman
26. The Relation of the Common Crow (Corvus brachyrhychos Brehm.) to Pecan Culture Wm. E Hoffman
27. K. S A C. Botan cal Notes, 1923. Frank C Gates.
    (Published in this volume of the Transactions)
28. Tillage and Weeds Frank C Gates, M C. Sewell
    (Ecology, Vol. 6, pp 138-142, 1925)
29. Notes on Human Inheritance, with Charts Robert K Nabours.
    (Eugenic News, Vol 11, pp 150-159, 1920, by L C Thomas)
30. The Reproductive System of Apotettix sp. Mary T. Harman.
31. Chromosome Studies in Cavia cobaya Mary T Harman and F. P Root.
32. Notes on the Migration of the Monarch Butterfly Nellie M Payne.
33. Local Longevity—Statistics from McPherson Cemetery H J. Harnly.
34. Systemat c Effects of Bright Light C I Reed
35. A List of the Literature on Kansas Insects J W McColloch
    (Jour Kans Ent Soc , Vol 1, pp. 3-19, 1928)
36 A Prelim nary Annotated List of the Ants of Kansas Wm P. Hayes.
    (Entomological News, Vol. 36, pp 10-12, 39-43, 69-73, 1925)
37. Field Studies of the Diurnal Raptores of Eastern and Central Kansas H K Gloyd
    (Wilson Bulletin, Vol. 37, No 3, pp 133-149, 1925)
38. A New Kansas Meteorite. H H Nininger
    (Published in this volume of the Transactions)
39. Notes on Kansas Meteorites. H. H Nininger
    (Published in this volume of the Transactions)
40. Pleistocene Fossils from McPherson County, 1921 to 1924 H. H. Nininger.
    (Published in this volume of the Transactions)
41. The Larger Felliwship of Science. Dr. Kurtz
42. The Effect of Pure Oxygen on Animal Life. J Willard Hershey.
    (Abstract published in this volume of the Transactions)
43 A Census of Insects in Alfalfa Fields at Manhattan. Part 1 Roger C. Smith.
44 Some Applications of Genetics to the Problems of Plant Breeding and Crop Improvement. John H. Parker.
45 Inheritance of Two New Factors in Chinchilla Rabbits H L Ibsen.
46 Manganese Mineral from Central Kansas H C. Allen, Wm Oberlin.
47. Examinations of Crude Oil from Weich Well, 35-20 W. H. C Allen, Ignace Ma m.
48. Effect of Heating on Iodine Number of Lubricating Oil. H. C Allen, H. W Palkowsky
49. Effect of Boiling on Viscosity and Free Carbon in Lubricating Oil. H. C. Allen, Guy Sackett, Miles Kennedy
50 Growth and Development of Young Great Horned Owls. Bess e P Reed.
51. On the Occurence of Human Tape Worms at Manhattan. A. W. Stover.

MINUTES OF THE FIFTY-SIXTH ANNUAL MEETING

The meeting was called to order by the president, H. P. Cady, at 10:30 Friday morning. The minutes of the fifty-fifth meeting were read and approved. The president appointed the following committees:

Program: Nininger, Rankin.

Resolutions: Dean Sayre, Bailey, Willard.

Auditing: Ackert, L. C. Wooster.
Membership: Secretary, as chairman ex officio, and Havenhill.
Publishing: White, Willard, Dains.
Press: Knaus, Nabours.
Legislative: Dean Sayre, Dean Willard.
Research: Dains, Parker, L. C. Wooster.
Parks: McColloch, Miss Meeker, Knaus, Yates.
Nominating: Taft, Hershey, Gloyd.
Necrology: Sayre, L. C. Wooster, Bailey.

By motion each paper was limited to ten minutes. The reading of papers then proceeded. A few minutes of the Saturday session were given Professor Osborne, representing the American Association for the Advancement of Science, whose purpose was to promote the relations between the American Association and the Kansas Academy.

The committee on resolutions expressed appreciation for the entertainment committee's arranging for a luncheon and a banquet, their gratification at the completion of the Harnly Science Hall at McPherson College, and called for a rising vote of thanks to Professor White for his splendid, unselfish work in continuing as secretary and as custodian of the Academy library.

The treasurer reported $315.40 in the treasury. The auditing committee then reported the accounts to be correct.

The membership committee reported the following new members added during the year W. B. Balch, Manhattan; R. J. Barnett, Manhattan; Edgar W. Davis, Manhattan; J. H. Bradley, Russell; H. Ernest Crow, Wichita; F. D. Farrell, Manhattan; C. A. Gunns, Manhattan; C. G. H. Johnson, Linn; F. E. Kester, Lawrence; Mary E. Kitchen, Emporia; E. H. Lindley, Lawrence; C. Wm. McCampbell, Manhattan; Ray McClellen, Lawrence; U. G. Mitchell, Lawrence; C. J. Posey, Lawrence; M. E. Rice, Lawrence; W. H. Skinner, Lindsborg; Leo. A. Sutter, Wichita; H. C. Tracy, Lawrence; P. J. Wedel, Newton; S. H. Whitcomb, Lawrence; L. D. Wooster, Hays; W. A. Wunsch, Fort Stanton, New Mexico.

Frank U. G. Agrelius and Emil Olof Deere were elected life members.

The publishing committee reported that nothing had been printed during the year on account of lack of funds.

The nominating committee reported the following for officers for 1924-1925:

President, H. H. Nininger; first vice-president, J. E. Ackert; second vice-president, F. U. G. Agrelius; treasurer, L. D. Havenhill; secretary, E. A. White; additional members of the executive council, R. K. Nabours, J. E. Welin, H. P. Cady, J. T. Willard. They were unanimously elected.

—E. A. WHITE, Secretary

Report of the Treasurer

Receipts:

Balance brought forward from 1923		$271.89
Interest		10.00
Dues from A. A. A. S. members		66.00
Annual dues from K. A. S. members		41.00
Total dues received	$107.00	
Total Receipts		$388.89

Expenses:

Items pertaining to office of secretary	$ 73.49
Cash on hand April 2, 1924	$315.40

—L. D. HAVENHILL, Treasurer

FIFTY-SEVENTH ANNUAL MEETING

KANSAS ACADEMY OF SCIENCE

Manhattan, April 10 and 11, 1925

OFFICERS FOR 1924-1925

H. H. Nininger, McPherson ---------- President
J. E. Ackert, Manhattan ---------- First Vice-President
F. U. G. Agrelius, Emporia ---------- Second Vice-President
L. D. Havenhill, Lawrence ---------- Treasurer
E. A. White, Lawrence ---------- Secretary
R .K. Nabours, H. P. Cady, J. E. Welin, and J. T. Willard; Additional Members of the Executive Council

PROGRAM

Friday, April 10, 1925

10:30 a. m. Business. Reading of Papers.
1:00 p. m. Business. Reading of Papers.
8:00 p. m. Presidential address by H. H. Nininger: "Observations on Meteorites with Special Reference to Kansas."

Saturday, April 11, 1925

8:30 a. m. Reports of Committees. Reading of Papers.
11:00 a. m. Meeting of the new Executive Council.

PAPERS SUBMITTED AT THE FIFTY-SEVENTH SESSION

1. Darwin's Theory of Evolution. Is it True, or Has It Been Weighed in the Balance and Found Wanting? J. M. McWharf.
2. K S A C. Botanical Notes, 1924 F. C. Gates.
   (Published in this volume of the Transactions)
3. The Ranunculaceae of Kansas. J. W. Swallen.
4. The Effect of Environmental Conditions and Removal of the Glumes on Smut Infection in Oats. C O Johnston
   (Phytopathology, Vol. 17, pp. 31-36, 1927)
5. Studies on the Smut of Maize. L. E Melchers.
6. Archaeology of the Cornfields District, Arizona. Albert B. Reagan.
   (Published in this volume of the Transactions)
7. A New Cicindelid from Oregon and a new Starategus from Texas. W Knaus.
8. Plectrodera scalator Fab Abundant at Medora, Kansas, in 1924. W. Knaus.
9. The Green Clover Worm, Plathypena scabra Fabr. (Noctuidae), in Kansas. Roger C Smith
10. Education from the Standpoint of Biology. L C Wooster
    (Teaching, Kansas State Teachers College of Emporia, 1928)
11. Giant Nerve Fibers and Their Functions in Crayfish George E Johnson.
    (Jour Comp. Neur., Vol. 42, pp. 19-33, 1926)
12. Landmarks in the Study of Insect Hibernation. Nellie M Payne.
    (Ent News, Vol. 37 (4) pp 99-101, 1926)
13. Methods of Rearing Oak Boring Larvae Nellie M. Payne
14. A Preliminary Report on the Inheritance of Color Pattern in Mantidae E H. Ingersoll.
15. Botanical Notes for 1924. Frank U G. Agrelius.
16. Some New Characters in Guinea Pigs that Have Proven to be Non-heritable. H. L Ibsen.
17. Sugars. Further Remarks on. L. E. Sayre
18. Glycerine. Some Useful Statistics. L. E Sayre.
19. Extension of the Natural Range of Two Mammals in Clay County, Kansas John H Schaffner
    (Published in this volume of the Transactions)
20. The Mushroom Rocks near Carneiro, Kansas H J. Harnly.
21. The Reproductive System of Apotettix eurycephalus Hancock Mary T Harman
    (Jour. Morph and Physiol, Vol. 41, No 1)
22. The Chromosome Complex of Cavia cobaya Mary T Harman and Frank Root
    (Biol. Bull, Vol 51, No. 2)
23. Further Studies on the Abnormalities of the Central Nervous System of the Chick Lenora K Doll (Introduced by Mary T. Harman)
24. New Plans for Eugenic Education. William Goldsmith.
25. Rate of Growth and Locomotion of the Proglottides of Taenia saginata. William Goldsmith
26. Water Solubility An Economic Force E. H. S Bailey.
27. A Soil Study in Scott County, Kansas. M C Sewell and W L. Latshaw.
    (Published in this volume of the Transactions)
28. Another Kansas Meteorite. H. H Nininger.
    (Published in this volume of the Transactions)
29. A new Kansas Aerolite, Referable to the Fall of November 9, 1923 H. H Nininger.
    (Published in this volume of the Transactions)
30. Some Pedigrees Showing Inheritance of Human Traits. Robert K. Nabours.
31. A Study of the Blood Cells of Normal Rabbits. Edna Bangs. (Introduced by Dr. L D. Bushnell)
    (Published in this volume of the Transactions)
32. Evidence of Stream Piracy on the Dakota Hogback Between Golden and Morrison, Colorado. Walter H Schoewe.
    (Published in this volume of the Transactions)
33. Evidence of the Rocky Mountain Peneplain at Nippa Mountain, Colorado. Walter H. Schoewe.
34. A Study of Suppression of Growth in the Albino Mouse with Special Reference to Initial Age as a Factor Influencing Resumption of Growth. Emily M Bennett.
35. The Problematical Hybrid Grosbeak. H. H. Nininger
    (Published in this volume of the Transactions)

36. The Bullock Oriole in Kansas. H. H Nininger
(Published in this volume of the Transactions)
37. The Trend of Real Estate Taxation in Kansas from 1910 to 1923. Eric Englund
38 Trends in Farming in the Hard Winter Wheat Belt. W. E. Grimes.
39. Glands and Personality. G H. Bretnall.
40 Posture and Health G H Bretnall
41. Electronization. H P Cady and Robert Taft
42 Current Density and Electrolytic Oxidation and Reduction. H. P. Cady and Robert Taft
43 Entropy of Vaporizat on. Robert Taft
44 Some Recent Experiments on the Effect of Ultra-Violet Light upon Chickens. J S Hughes and R W. Titus
45. Cultural and Varietal Tests with Tomatoes Walter B Balch
46. The Inher tance of Twinn ng in Holsteins. R. H Lush
(Jour of Heredity, Vol 16, pp 273-279, 1925)
47 The Effect of Multiple Turning in Hatchibility of Eggs Loyal F Payne
48 Supplies of Farm Storage Space and Bank Cred t in Relative Early Marketing of Wheat R M Green
49 Egg Masses of Some Chironomidae Hazel E Branch
50 The Deer Creek Reservation and its Indians Albert B Reagan
51. The Effect of 99 97 per cent Oxygen and 03 per cent Carbon Dioxide by Volume upon Animal Life J Willard Hershey
(Abstract published in th s volume of the Transactions)
52 Some Propert es of Nitric Oxide A A Groening
53 A Survey of the Reptiles and Amph bians of Ellis County L. D Wooster.
54 An Exhibit of Biological Draw ngs S Fred Prince
55 The Effect of Parasitism of the Thymus Glands of Chickens James E. Ackert.
56 The Relation of Paras tism to the Blood Sugar Content of Chickens James E. Ackert and R W Titus
57 Observations on the Hibernat on of Insects in Sudan Grass. H R Bryson
58 Further Notes on Diurnal Raptores with Key for Field Identification Howard K. Gloyd.
59. Recent Developments in Zoological Technique C A Gunns.
60 Inheritance of Shank Color in Poultry D C Warren
61 Cigarette Smoke and Grow ng Rabbits. W J Baumgartner.
62 A New Boiling Po nt Apparatus Howard T Morgan and Howard M Elsey
63 A Combined Projection Lantern and Electroscope Howard M Elsey.
64. Relative Viscos ty Measurements and Calculations C G H Johnston and H M Elsey
65 Some Organ c Oxidation and Reduction Cells H P. Cady, R Q Brewster, Selma Gottlieb and M C Moore
66 Observations on the Gastropods of the Manhattan Vicinity Elmer Cheatum
67 The Tolerance of Fish to Hydrogen Ion Concentration in Nature Harold Brown.
(Trans Amer M cro Soc, Vol. 45, pp. 20-34, 1926)
68 An Unusual Infection of a Rabbit with Tape Worm Cysts M nna E Jewell.
(Trans of the Helminthological Soc of Washington, 1925)
69 A Time Study in Infant Care Lucille Rust.
70 A Study of the Health of Seventy-one Elementary School Children. Jean S Dobbs.
71. Electrolysis and Other Troubles Caused by Leakage Currents from Electric Railroads Wm H Mathews
72. The Relation of Vitamin B to Parasit sm in Chicks. Lola B. Vincent.

MINUTES OF THE FIFTY-SEVENTH ANNUAL MEETING.

The first session was called to order by the president, H. H. Nininger, at 10:30 on Friday morning.

The minutes of the fifty-sixth annual meeting were read and approved. The president appointed the following committees:

Program: Agrelius, Gates.

Resolutions: Knaus, Yates, Rankin.

Auditing: Taft, Smith.
Membership: White, Havenhill.
Publishing: White, Willard, Hershey.
Press: Goldsmith, Knaus.
Legislative: Sayre, Willard.
Research: Nabours, Schoewe, Weidlein.
Parks: McColloch.
Nominating: Harnley, Nabours, Wooster, L. C.
Necrology: Wooster, L. D., Brooks, C. H.

Papers were then read until noon.

At 1:30 p. m. a short business session was held. It was decided that a copy of each paper that is to be presented at the annual meeting be filed at the secretary's office for reference. Telegrams were sent to Dr. E. H. S. Bailey, Dean L. E. Sayre, and Secretary of Agriculture Jardine.

Papers were read until five o'clock when an automobile trip was taken. At six o'clock, the local members gave a banquet to the visitors. The evening was given over to a lecture on meteorites by President Nininger.

A few papers were read Saturday morning, but a large part of the time was taken by reports of committees.

The resolutions committee expressed appreciation to the resident members for their hospitality, gratification over the growth of the Academy, over the unusually large attendance of working members from many Kansas institutions. They pledged the support of the Academy to President-elect J. E. Ackert, and extended wishes for a successful year on leave of absence for the retiring president, H. H. Nininger.

The membership committee reported that the following new members have been added during the year: Alfred S. Perkins, Manhattan; W. L. Latshaw, Manhattan; George E. Johnson, Manhattan; Maurice A. Walker, Lawrence; E. H. Ingersoll, Manhattan; R. Q. Brewster, Lawrence; V. R. Vergaldis, Clay Center; Wm. Bergen, McPherson; C. F. Gustafson, Kansas City, Mo.; R. W. Titus, Manhattan; Carl Schneider, McPherson; Wm. M. Goldsmith, Winfield; Ruth Thompson, Sterling; John Jason Meyer, Salina; A. A. Groening, Hillsboro; Lucille C. Rust, Manhattan; Jason Swallen, Manhattan; Martha Kramer, Manhattan; Martha Pittman; Margaret Justin, Manhattan; Pearle E. Ruby, Manhattan; Minna E. Jewell, Manhattan; R. M. Green, Manhattan; Martha E. Foster, Manhattan; Eric Englund, Manhattan; Jean Dobbs, Manhattan; May Danheim, Manhattan; H. R. Bryson, Manhattan; Lillian Baker, Manhattan; Elmer Cheatum, Manhattan; Lola B. Vincent, Manhattan, E. C. Converse, Manhattan; J. O. Hamilton, Manhattan; G. E. Raburn, Manhattan; A. W. Angulo, Manhattan; D. H. Spencer, Lawrence; M. C. Sewell, Manhattan; R. H. Lush, Manhattan; Naomi B. Zimmerman, Manhattan; C. W. McCampbell, Manhattan; Arthur D. Weber, Manhattan; B. M. Anderson, Manhattan; Merle Suter, Wifield; W. E. Grimes, Manhattan.

Report of the Parks or Ecological Committee

During the past year your committee has continued the cooperation with the committee on the preservation of natural conditions of the Ecological Society of America.

A general account of the ecological features of Kansas was prepared for the Naturalist's Guide. The descriptions of twelve natural areas in Kansas which were submitted to the committee were edited and prepared for publication, thirteen additional areas were located and described

A series of maps were also prepared showing the various ecological features of the state and the location of the several areas suggested for preservation

A bibliography of the insects of Kansas has been compiled. This now contains approximately 100 titles.

Recommendations:

Your committee would recommend that the cooperation with the Ecological Society of America be continued and that additional natural areas be described. At present only seventeen counties are represented in this survey, while it is hoped that eventually there will be at least one area in each county

Your committee would also recommend that the Kansas Academy of Science undertake or sponsor an ecological survey of the state which would consider: (1) the ecological features of the state, (2) annotated lists of the plants and animals, giving distribution, habitats, and other essential data, (3) bibliography of the ecological literature of the state, and (4) ecological surveys of typical areas in the state.

This recommendation is made because there is a great need for a comprehensive ecological survey of the state Investigators in various lines of biological research are often handicapped by the meager data on the ecological features of the state and by the lack of complete lists of plants and animals

A great change has taken place in the biota of Kansas during the past fifty years. Approximately 84 per cent of the land area has been transformed from native conditions to farm land with the result that many animals and plants, once abundant, have disappeared while many others have been introduced. Fortunately this change has been recent and it is still possible to study the succession of plant and animal life following the interference of man. The disappearance of the buffalo and some of the larger game has had a marked influence on the biota of the state, as has the introduction of such plants as wheat, corn, sorghum and alfalfa. Kansas also presents an excellent field for ecological studies because of its central location, its prairies and plains, and its humid and semiarid regions.

Much of the pioneer work has been done along various lines This work, however, is often fragmentary and scattered through many publications For example, in 1877 Popenoe published a preliminary list of the Coleoptera of Kansas in which about 1 200 species were enumerated Since then sixteen additional lists have been published and approximately 3,500 species have been recorded These lists should be brought together and revised, since there is considerable confusion resulting from changes in synonomy and erroneous determinations, especially in the earlier papers

There has been no attempt made to compile a complete list of the insects of Kansas. Certain orders have been treated extensively, while others have been woefully neglected The literature on Kansas insects comprises over 100 papers published in more than fifteen journals and this information should be brought together.

The same condition applies to other groups of animals and to plants, and offers an excellent field of work for this Academy. This is in line with similar work now under way in a number of states. Illinois, through its State Laboratory of Natural History, is conducting ecological surveys in that state and their Academy of Science has an ecological survey committee. The Geological and Natural History Survey of Connecticut has issued a number of catalogues and checklists of different groups of animals and plants of that state.

In making this recommendation, your committee feels that many valuable papers would be secured for publication in the Transactions and that it will offer an opportunity for a large number of members to cooperate in bringing this material together.

J. W. McColloch
R. L. Hensel
Grace Meeker

The necrology committee reported that no deaths had occurred.

The nominating committee reported the following nominations:

President, J. E. Ackert; first vice-president, H. M. Elsey; second vice-president, Wm. Goldsmith; treasurer, L. D. Havenhill; secretary, E. A. White; additional members of the executive council: H. H. Nin-

inger, Roy Rankin, G. H. Bretnall, and Hazel Branch. The nominees were all unanimously elected. Dr. W. R. B. Robertson of Columbia, Missouri, Theodore H. Scheffer, Washington, D. C., and Dean P. F. Walker, University of Kansas, were made life members of the Academy.

E. A. WHITE, Secretary

Report of the Treasurer

Receipts:		
Balance brought forward		$315.40
Received from new members		36.00
Received from American Association members		66.00
Other membership dues		20.00
Total dues received	$122.00	
Total receipts		$437.40
Expenses:		
E. A. White, secretary		$100.00
Stationery		22.45
Stamps		27.00
Stenographic and office assistance		51.40
Express		.57
		$201.42
Expenses of executive committee meeting, January 10, 1925, at Lawrence:		
F. U. G. Agrelius		$ 3.41
H. H. Nininger		13.13
J. E. Ackert		5.62
R. K. Nabours		5.62
J. T. Willard		5.62
		$ 33.40
Total expenses		$234.82
Total cash on hand		$202.58

L. D. HAVENHILL, Treasurer

FIFTY-EIGHTH ANNUAL MEETING

KANSAS ACADEMY OF SCIENCE

Winfield, Kansas, April 16 and 17, 1926

OFFICERS FOR 1925-1926

J. E. Ackert, Manhattan ________ President
H. M. Elsey, Pittsburgh, Pa. ________ First Vice-President
Wm. Goldsmith, Winfield ________ Second Vice-President
L. D. Havenhill, Lawrence ________ Treasurer
E. A. White, Lawrence ________ Secretary
H. H. Nininger, G. H. Bretnall, Roy Rankin, and Hazel Branch, Additional Members of the Executive Council

PROGRAM

Friday, April 16, 1926

10:00 a. m. Business. Reading of Papers.
1:30 p. m. Business. Reading of Papers.
8:00 p. m. Presidential address by J. E. Ackert. "Biology in the Service of Mankind."

Saturday, April 17, 1926

8:00 a. m. Business. Reading of Papers.

PAPERS SUBMITTED FOR THE FIFTY-EIGHTH SESSION

1. List of the Fungus Flora of Kansas Elam Bartholomew
(Fungus Flora of Kansas Special Bull Kansas Ag Expt Sta, 1927)
2. Botanical Notes for 1925 Frank U G Agrelius.
3. An Example of Specificity of Heat Stimulation Nellie M Payne.
4. Ecological Areas in South Dakota. E. C O'Roke.
5. Longevity in McPherson County H J. Harnly.
6. A Colorimetric Reaction of Pectin H. Werner.
7. The Haskell Till Deposit. Walter H Schoewe.
8. Erosion Pillars in the Morrison Formation of Garden Park, Colorado. Walter H Schoewe.
9. Physical Training a Factor in Character building. J. M McWharf.
10. The Snakes of Franklin County, Kansas, a Check-list of Species with Notes on Feeding Habits and Life Histories Howard K Gloyd.
(Published in this volume of the Transactions)
11. The Ability of the Textile Fibers to Transmit Ultra-Violet Light Mrs. Katherine Hess.
(Jour of Agri Research. Vol 35, No. 3, 1927)
12. A Birds-per Acre Survey. L D. Wooster.
13. The Making of a Chromosome Map. Robert K. Nabours.
(Included in Kans Tech Bull. 17, pp. 1-231, 1925)
14. Resistance of Chickens to Parasitism. James E. Ackert.
15. Parasitism, as Affected by a Diet Deficient in the Fat-Soluble Vitamins. Marian Fisher (Introduced by James E. Ackert)
(Jour. Parasit., Vol. 13, No. 3, 1927 —abstract)
16. Biological Method for the Disposal of Dairy Wastes. Hazel E. Branch.
(Cornell Univ. Agric. Exp. Sta. Bull. 425)

17 Parthenogenesis in the Grouse Locust, Paratettix texanus Hancock Robert K Nabours and Martha E. Foster.
18 Correlation of the Permian of Southern Kansas and Northern Oklahoma C. N Gould
19. Early Geology of Southern Kansas C N. Gould.
20. Relief Map of Cowley County Based on Well Records to the Mississippi Limestone M W Baden
21. A Preliminary Study on the Inheritance of the Columbian Plumage Pattern in Poultry Ray Porter (Introduced by William M Goldsmith)
22. Inheritance in Poultry as a Basis for the Teaching of Elementary Genetics William M Goldsmith
23. Primary Forces H G Baker
(Published in this volume of the Transactions)
24 The Role of Euthenics in Eugenics. H G. Baker
(Social Science, Southwestern College)
25. The Effect of Pure Oxygen Upon Water Animals J Willard Hershey.
(Abstract published in this volume of the Transactions)
26. The Tray System for Insect Collections Roger C Smith
(Published in this volume of the Transactions)
27. The Basal Metabolism of Overweight Female Subjects on Certain Reducing Diets. Neva C McDonnell and Martha M. Kramer
28 Sex Ratios in Guinea Pigs Sumner O Burhoe
29. Unusual Ratios in the E Series in Guinea Pigs Harold P Morris
30. Effects of Cigarette Smoke on Growing Mammals W. J Baumgartner
31 K S A C Botanical Notes for 1925 F C Gates.
(Published in this volume of the Transactions)
32 A Preliminary Study on the Interchange of Soil by Insects. Harry R Bryson
33. Dehydration Products of Acetone Glenn Bickford.
34. A Study of Nitration Products of Several Aromatic Hydro-carbons Wayne White
35 Reducing Agents Used on Aromatic Nitro Compounds Theodore Shull
36. A Brief History of Chinese Chemistry Szu Chih Liu
37. The Coccinellidae of Kansas (Coleoptera). Harry L Gui
(Jour Kans Ent Soc, Vol 1, pp 2-13, 1928)
38. Kansas Grown Digitalis L. D Havenhill
(Abstract published in this volume of the Transactions)
39 Archaeology of the Cornfields-Hopi Volcanic Buttes' Field
(Published in this volume of the Transactions)
(b) Stories of the Red Children of the Northwest Albert B Reagan
40. The Fishes of the Salt Marsh of Stafford County, Kansas. Frank Jobes
41. The Invertebrates of the Salt Marsh of Stafford County, Kansas Harry Walker
42. Observations on Young Prairie Dogs George E. Johnson
(Jour Mammal, Vol. 8, pp. 110-115, 1927)

MINUTES OF THE FIFTY-EIGHTH ANNUAL MEETING

The Academy held its fifty-eighth annual meeting at Southwestern College, Winfield, Kansas, April 16, 17, 1926. In addition to the papers on the program of the Academy, twenty papers were presented by members of the Oklahoma Academy. At the usual dinner Friday evening, several talks were made by members from both states.

At the first session Friday morning, the president, Dr. J. E. Ackert, appointed the following committees:

Program: L. Oncley, A. O. Weese, F. C. Gates.
Resolutions: F. U. G. Agrelius.
Auditing: L. D. Wooster, W. B. Wilson.

Membership: E. A. White, Roy Rankin, R. C. Smith, J. W. Hershey, H. K. Gloyd.
Publishing: W. M. Goldsmith, E. A. White.
Press: R. B. Dunlevy.
Parks: J. W. McColloch.
Nominating: R. K. Nabours, Roy Rankin, Hazel Branch.
Necrology: H. J. Harnly, J. T. Willard.

Papers were read to 11:30, when the Academy adjourned to meet at 1:30. Business was taken up at 1:30. The president explained the present plan of the affiliation of the Academy with the American Association for the Advancement of Science whereby the Academy receives fifty per cents per member from the A. A. A. S. instead of a dollar as formerly.

The following amendment to the constitution was then proposed, that section 3, article 2, shall read as follows:

National members shall consist of those who are also members of the American Association for the Advance of Science Each national member except life members of the Academy shall pay to the American Association for the Advancement of Science, its annual fee and shall pay to the Academy an annual fee of $1 00 National life members of the Academy shall pay to the American Association for the Advancement of Science its annual assessment

The classification of members, together with the fees to be paid is as follows

1 Honorary No dues.
2 Active
  (1) Local
    (a) Annual, dues $1 00 per year.
    (b) Life, no dues
  (2) National
    (a) Local life, national annual, no dues
    (b) Local life, national life, no dues
    (c) Local annual, national life, dues $1 00 per year.

Copies of this amendment were then given out so it could be studied until the next day.

A report was made concerning the proposed Rocky Mountain Division of the A. A. A. S. Of 203 circulars sent out, 135 were returned, 133 voting against the proposed division and 2 in favor of it. By motion it was decided that the Kansas Academy of Science should not join the Rocky Mountain Division.

After reading of papers and adjournment, the members who wished joined with several of the citizens in an automobile ride through the nearby oil fields.

At the business meeting Saturday morning, W. A. Cook of Salina, was elected a life member of the Academy.

The president again read the proposed amendment to the constitution. It was adopted by an unanimous vote.

The resolutions committee submitted resolutions extending thanks to the president and faculty of Southwestern College, the Southwestern Science Club, the Chamber of Commerce, and other citizens of the city of Winfield for their very cordial welcome and many courtesies, expressing gratification at the presence of the members of the Oklahoma Academy of Science, and at the presence of an unusually large number of high school faculty members.

The auditing committee reported the books of the treasurer as cor-

rect. The membership committee reported 250 active members and 52 new members.

The following was the report of the nominating committee:

President, H. J. Harnly; first vice-president, Mary T. Harman; second vice-president, L. D. Wooster; treasurer, L. D. Havenhill; secretary, E. A. White; additional members of the executive council, J. E. Ackert, W. B. Wilson, Hazel Branch, Wm. Goldsmith. By motion these nominees were elected.

The necrology committee reported that Dean Sayre and Dr. Keller passed away during the past year.

The secretary reported that several copies of the Transactions had been sent out and much material received. The Academy library is still on the fifth floor of Fraser Hall, but the pamphlets are being moved to the library building and being classified. The books will be moved as soon as more stocks are built. For the last year the interest taken in the Academy, both by members and outsiders, has been greater than ever before.

The meeting adjourned.

E. A. WHITE, Secretary

FIFTY-NINTH ANNUAL MEETING

KANSAS ACADEMY OF SCIENCE

Lawrence, April 15 and 16, 1927

OFFICERS FOR 1926-1927

H. J. Harnly, McPherson ---------------------------------- President
Mary T. Harman, Manhattan ----------------- First Vice-President
L. D. Wooster, Hays -------------------------- Second Vice-President
L. D. Havenhill, Lawrence ---------------------------------- Treasurer
E. A. White, Lawrence ----------------------------------- Secretary
J. E. Ackert, Hazel Branch, W. B. Wilson and Wm. Goldsmith,
Additional Members of the Executive Council

PROGRAM

Friday, April 15, 1927

10:00 a. m. Business. Reading of Papers.

1:30 p. m. Business. Reading of Papers.

8.00 p. m. Presidential Address by H. J. Harnly: "Longevity and Other Matters."

Address by Dr. Kurtz: "The Scientific Method."

Saturday, April 16, 1927

8:30 a. m. Business. Reading of Papers.

PAPERS SUBMITTED FOR THE FIFTY-NINTH SESSION

1. (a) Chapter on Farm and Home Economic Advancement. E. H S Bailey.
   (b) How the Chemist is Conserving the Food Supply E H S Bailey
2. Scientific Methods in Commercial Research as Exemplified in Wheat Price Studies. R M Green.
3. (a) Viscosities and Electrical Conductivity of Stannic Chloride-Acetic Acid Systems. John Strong and J D Stranathan.
   (b) Lecture Experiment with the Atmophone John Strong
4. Conditions in Hibernation in Citellus tridecemlineatus pallidus. George E Johnson
   (Jour. Exp. Zool., Vol 50, pp. 15-30, 1928)
5. Ovarian Grafting in Guinea Pigs Earl Herrick
   (Abstract published in this volume of the Transactions)
6. The Anterior Pituitary Body and Hibernation Ben R Coonfield
7. Botanical Notes for 1926. Frank U G Agrelius
8. The Stages in the Development of Life L. C Wooster
   (Teaching, Kansas State Teachers College of Emporia, 1928)
9. (a) K S. A C Botanical Notes, 1926 Frank C Gates
   (Published in this volume of the Transactions)
   (b) Cladonia and Seedling Mortality Frank C Gates
10. The Embryo of a Squid Mary T Harman and Ann Hinshaw Gardiner
   (Pug Sound Biol Sta Vol 5)
11. The Development of the Spermatozoon of Cavia cobaya (the Common Guinea Pig). Mary T Harman and Frank Root
   (Biol Bull —In press)
12. The Efficacy of Cod Liver Oil in Building Up Resistance to Lung and Nasal Affections in Guinea Pigs and Rabbits Heman L Ibsen
13. The Application of the Scientific Method to Personality Problems in High School and College Students Drs Karl and Wm Menninger
14. The Behavior of Certain Lyophile Colloids in Liquid Ammonia Robert Taft.
15. Hybrid Vigor in Poultry D C Warren
   (Poultry Science, Vol 7, pp. 1-8, 1927)
16. Report of Some Distributional Studies of Aquatic Hemiptera H B Hungerford.
17. (a) The effect of a Mixture of Argon and Oxygen and a Mixture of Helium Upon Animal Life J W. Hershey
   (Abstract published in this volume of the Transactions)
   (b) A Film Flames of Atomic Hydrogen J W. Hershey
18. A Summary of the Courses in Entomology in American Institutions of Higher Learning Roger C Smith
   (Kans State Agr Coll Bull, Vol 12, No 1, 23 pages, 1928)
19. The Genus Driotura Paul B Lawson
20. Further Studies of the Reaction of Opalinas to Various Laboratory Media with Special Reference to Their Longevity Mary E Larson and Fred W Allen, Jr.
21. Nectar Collection by the Honeybee. R L Parker.
22. Bird Investigations for 1926 L. D Wooster.
23. Effect of Warm Moist Air on the Surface of the Body. G H Bretnall.
24. A New Record to the Parasites of Pholus achemon Drury Hazel E. Branch.
   (Published in this volume of the Transactions)
25. Why Do We Age? J M. McWharf.
26. (a) Additional Evidence of an Ice Invasion of the Kansas River in Eastern Kansas Walter H. Schoewe
   (b) Erosional Pillars Walter H Schoewe
27. Some Entomological Observations in Republic of Honduras Reginald H. Painter.
   (Annual Report of Med. Dept. of United Fruit Co, 1926, pp. 245-262)
28. A Preliminary Contribution to the Life History of the Timber Rattlesnake. Howard K. Gloyd.
29. Notes on the Growth of the Snapping Turtle. C. W. Clanton.
30. (a) A New Aerolite from San Antonio, Texas.
   (b) Observations on Texas Meteorites
   (c) Pleistocene Footprints from Central Arizona
   (d) Fossil Footprints in the Big Bend Country in West Texas.
   (e) Days with the Wild Turkey in Texas.
   (f) The Vanishing Whooping Crane. H. H. Nininger.
31. 1926 Collecting on Kansas Coleoptera. Coleoptera as Dwellers in the Home of Other Insects and in the Burrows of Animals and Insects. W. Knaus.

32. The Sugar Acids Preparation of 1, 2 Dihydroxy Butyric Acids Sybil Woodruff
33 Polyandry in the Grouse Locust (Paratettix texanus) with Notes on Inheritance of Acquired Characters R K Nabours
(Amer Naturalist, Vol 41, pp 531-538, 1927)
34 Parasitism and the Thyroid Gland J E Ackert and G. F. Otto.
35. Parasitism and Vitamin D in Chickens L A Spindler.
(Jour. Parasit, Vol 14, p 133, 1927 —abstract)
36 (a) The Polvaders Meteorite
(b) Notes on the Cornfields Region, Arizona, a continuation of 1925 Report
(Published in this volume of the Transactions)
(c) Glories of the Canyon of the Colorado Its Proposed High Bridge and Colossal Dam Albert B Reagan
37 An Analogue of the Cupric Ammonia Ion in Acetic Acid Solution Arthur W. Davidson.
(Abstract published in this volume of the Transactions)
38 Research at University of Kansas by Faculty and Students R Q Brewster
39. Research at Kansas State Agricultural College J E Ackert
40. Research at Kansas State Teachers College, Emporia Frank U G Agrelius
41. Research at Kansas State Teachers College, Pittsburg J. A. Yates
42 Research at Kansas State Teachers College, Hays Roy Rankin
43 Research at Baker University E J Cragoe
44. Research at Washburn College. Wm M Harshbarger
45 Research at Ottawa University Wm B Wilson
46. Research at McPherson College J. Willard Hershey.
47. Research at Southwestern College, Winfield. Wm M Goldsmith
48 The Replaceability of Certain Methylene Groups, and the Relation of Constitution to the Stability of the C Equals C Linkage Harvey W Moyer and F B. Dains
49 The Synthesis and properties of the Mono-chloro-iodo-toluenes Henry J. Long and F B Dains
50. A Study of Height-Weight-Age Ratio in Indian Children Emily Ferris

MINUTES OF THE FIFTY-NINTH ANNUAL MEETING

The meeting on Friday, April 15, was called to order by the president, H. J. Harnly. President Harnly appointed the following committees:

Program: L. D. Wooster, Nininger.
Resolutions: Rankin, Yates.
Auditing: Warren, Hershey.
Nominations: Ackert, Schoewe, Agrelius.
Printing: White, Nabours, Smith, Wilson, Manchester.
Press: Knaus.
Parks: McColloch.
Necrology: Bailey, Willard.

Papers were then read until 12:00 o'clock.

The afternoon meeting was called to order at 2:00 p. m. by the president. Dr. Taft explained there would be no banquet this year, but that he had made arrangements for a get-together supper at the Thimble Tea Room at 6:00 o'clock.

Mr. Manchester, Director of Libraries at the University, led a short discussion regarding the Academy of Science Library. The books belonging to the Academy are now housed on the 5th floor of Fraser Hall, due to lack of space in Watson Library. The foreign exchange list is rapidly becoming decreased due to lack of recently published volumes. Members of the Academy were invited by Mr. Manchester to visit the Academy of Science library in Fraser Hall.

Dr. Bailey suggested that the Academy take over the publication of the Transactions.

The committee on Publications was instructed to study the question of financing the Academy publications and to report at the meeting next year.

The life members were invited to have their pictures taken and excused themselves from the meeting. Dr. Mary T. Harman, vice president, presided in place of H. J. Harnly, who is a life member.

The meeting Saturday morning, April 16, was called to order by President Harnly.

The resolutions committee extended thanks to Dr. Kurtz for his address, to the faculty of the University for courtesies shown the Academy, commended the action of the officers of the Academy, Librarian Manchester, and Chancellor Lindley, for their efforts to secure publication, and expressed appreciation at the presence of a number of life members at the meeting.

The auditing committee reported the books of the treasurer to be correct.

The following was the report of the nominating committee: President, Mary T. Harman; first vice-president, L. D. Wooster; second vice-president, W. B. Wilson; treasurer, L. D. Havenhill; secretary, E. A. White; additional members of the executive council, H. J. Harnly, J. E. Ackert, Hazel Branch, and G. H. Bretnall. By motion all of these officers were elected.

By motion it was decided that statements of the annual dues be sent to the members early in October to slightly precede the statements of the American Association for the Advancement of Science; and that directions be given for the method of payment of combined dues.

Mr. Warren Fred Farager was elected a life member of the Academy.

The Academy voted to accept the invitation of the Wichita Chamber of Commerce and the University of Wichia to hold the next meeting in Wichita.

A motion that the committee on printing be increased to five members, the president to appoint the additional members, was carried.

It was voted to get an opinion from the attorney general as to whom the library of the Academy of Science belongs.

By motion the committee on printing was instructed to place the Academy of Science Library in one of the institutions of the state which would properly house it and would pay some funds into the Academy for the exchanges received through the Transactions, which would pay for the publication of the Transactions.

It was voted that the Kansas Academy of Science recommend to the State Fish and Game Commission that the commission take under advisement the matter of stocking suitable portions of the state with wild turkey.

By motion it was provided that papers Nos. 38 to 47 inclusive regarding research work at the various institutions be omitted and that abstracts of these papers be mimeographed and sent to the members of the Academy.

E. A. WHITE, Secretary

Report of the Treasurer

Receipts:	
Balance carried forward	$219.00
37 dues @ $1.00	37.00
3 dues @ 50c (A. A. A. S.)	1.50
Interest on $200.00 @ 4 per cent for 2 years	16.00
Total receipts to April 15, 1927	$273.50
Expenses:	
H. J. Harnly, expenses to Lawrence	$13.58
Stenographic work, Winfield	5.00
Printing and telegram, Winfield	4.65
Secretary's expenses to Winfield	25.54
Stamps and post cards	15.50
Expenses executive committee, Topeka	3.65
President's expenses, Topeka	10.61
Printing, etc., Lawrence	11.75
Office and stenographic work	30.00
Total expenses to April 15, 1927	$120.28
Cash on hand April 15, 1927	$153.22

L. D. HAVENHILL, Treasurer

From Minutes of tthe Executive Council, January 10, 1925, Lawrence

The members present were Chairman Niniger, Ackert, Willard, Sayre, White, Agrelius, Nabours, Bailey for Cady, and Havenhill.

The executive council instructed the legislative committee to prepare a brief to be sent to Dr. Willard and Professor Agrelius, who were to see their legislators concerning the introduction of a bill to secure the Academy printing. Mr. Spilman of Manhattan was to be asked to assist in drafting the bill and a copy of the bill was to be sent to Professor Agrelius for use by Senator Parker.

L. D. HAVENHILL, Acting Secretary

SIXTIETH ANNUAL MEETING

KANSAS ACADEMY OF SCIENCE

Wichita, April 13 and 14, 1928

OFFICERS FOR 1927-1928

Mary T. Harman, Manhattan .... President
L. D. Wooster, Hays .... First Vice-President
W. B. Wilson, Ottawa .... Second Vice-President
L. D. Havenhill, Lawrence .... Treasurer
E. A. White, Lawrence .... Secretary
H. J. Harnly, J. E. Ackert, Hazel Branch and G. H. Bretnall,
Additional Members of the Executive Council

PROGRAM

Friday, April 13, 1928

10:00 a. m. Address by H. W. Foght.
Business. Reading of Papers.
1:30 p. m. Business. Reading of Papers.
8:00 p. m. Presidential Address by Dr. Mary T. Harman. "The Physical Unit of Life."

Saturday, April 14, 1928

8:30 p. m. Business. Reading of Papers.

PAPERS SUBMITTED FOR THE SIXTIETH SESSION

1 The Heats of Absorption of Certain Organic Vapors on Charcoal at 25° Centigrade Loyd McKinley
2 Twisted Atoms Loyd McKinley
3 A Study of Seasonal Variation of Deaths from Pneumonia in Certain Cities in the United States Margaret M Justin
4 A Uniform Test of General Intelligence J C Peterson
5 Botanical Notes for 1927 Frank U G. Agrelius.
6 Further Experiments with Bad Air G H Bretnall.
7 Some Notes on Kansas Geology L C. Wooster
8 Bird Population L C Wooster
9. The Chromosome Method of Presenting Mendalian Inheritance H L. Ibsen
10 Chinese Elms in the Prairie States Frank C. Gates
(Published in this volume of the Transactions)
11. Plant Migration Tendencies in Wabaunsee County, Kansas, 1898-1927. Frank C Gates
(Published in this volume of the Transactions)
12 Notes on the Chironomidae of Kansas Hazel E Branch.
(Published in this volume of the Transactions)
13 Concerning the Use of Nitro Compounds as Oxidizing Agents. W. A. Fletcher.
14. A New Method for the Preparation of $(NH_4)_2S_2NH_4SH$ W. A Fletcher
15. Filaria Worms and Fistulous Withers in Horses J. E. Ackert and W S O'Neal.
16 Resistance to Parasitism, and Vitamin B. L. O. Nolf (Introduced by J. E Ackert and Naomi B. Zimmerman)
17. Effect of Helminthiasis on Resistance to Parasitism. Roy W. Jones. (Introduced by J. E. Ackert)
18. Variations and Abnormalities in Certain Tapeworms. G. L Graham. (Introduced by J. E Ackert)
19. Factors Influencing the Productivity of Ponds of the State Fish Hatchery. Edw. Schneberger. (Introduced by Minna E. Jewell)

20 A Monstrosity in a Pig W J Baumgartner.
(Anat. Rec, Vol 37, No. 3, 1928)

21 The Effects of a Mixture of Pure Oxygen and Pure Argon upon the Animal Life with Various Amounts J W Hershey
(Abstract published in this volume of the Transactions)

22. The Effects of a Mixture of Pure Oxygen and Pure Nitrogen upon Animal Life with Various Amounts J W Hershey
(Abstract published in this volume of the Transactions)

23 A Review of Investigation on the Hibernation of the 13-lined Ground Squirrel George E Johnson
(In Preparation for the Quarterly Review of Biology)

24 The Effect of Anterior Pituitary Extract on Growth of Rats. E D. Sayles (Introduced by George E Johnson)

25 The Effects of the Alkaloids, Brucine Sulphate, Quinine Sulphate and Strychnine Sulphate, on Cell Division, Cell Activity, and Plant Growth Clinton C. McDonald

26. Some Interesting Facts About the Fossil Fish, Portheus molossus Geo. F. Sternberg

27. Rare Coleoptera from the Sandhill Region of Medora, Kansas W Knaus.

28 Northward Extension of Agrypnus sallei Lec to the Medora Sandhill Region of Kansas. W Knaus

29. Germicidal Effect of Ultra Violet Light on Fabrics and Through Fabrics Alph. Latzke.

30. The Early Development of a Polyclad Florence Stebbins. (Introduced by Mary T Harman)
(In preparation for Puget Sound Biological Station)

31 Study of Birth Weights with Relation to Age of Mother and to Season of Birth Helen W Ford
(Published in this volume of the Transactions)

32 Notes on Archaeology of the Cornfields Region, Arizona. Continued from the 1927 Report Albert B Reagan
(Published in this volume of the Transactions)

MINUTES OF THE SIXTIETH ANNUAL MEETING

The sixtieth annual meeting of the Kansas Academy of Science was held at Wichita, April 13 and 14, 1928. The afternoon session was held at the Central High School. All other sessions were held at the Municipal University of Wichita.

The meeting was called to order by the president, Dr. Mary T. Harman, at 10:30 a. m., April 13. Dr. H. W. Foght, president of the Municipal University of Wichita, welcomed the members of the Academy as guests of Wichita, and particularly as guests of the University. The minutes of the previous meeting were read and approved.

The following committees were appointed by the president:

Program: Agrelius, Gates, Baumgartner.

Resolutions: Ackert, Lawson, Goldsmith.

Auditing: Hershey, Justin.

Membership: Johnson, G. E., Larson, Agrelius, Rankin, Hershey, McDonald, Bretnall, Wilson, Moore, Goldsmith, Yates, Crow.

Press: Knaus.

Parks: McColloch.

Nominating: Rankin, Havenhill, Branch, Smith, R. C.

Necrology: Harnly, Willard.

The afternoon session was called to order by the president at 1:30. A half hour was devoted to seeing the science department of the high school. The reading of papers was resumed at two o'clock. The meeting adjourned at four-thirty to be guests of the Wichita Chamber of Commerce on a tour of the city.

A delightful banquet was served at 6:15 in the cafeteria of the University. Professor Crow of Friends University was toastmaster. Professor Emeritus Schwartz of Wichita University responded to a toast on "Reminiscences" and Dr. Goldsmith to one on "Eugenic Laws".

Dr. Mary T. Harman delivered the presidential address at 8:30 p. m., on the subject, "The Physical Unit of Life".

The Saturday meeting convened at 8:30 a. m. The report of the treasurer was made and accepted. E. A. White and Mary T. Harman were made life members.

The nominating committee submitted the following names as candidates: President, L. D. Wooster; first fice-president, W. B. Wilson; second vice-president, Hazel E. Branch; treasurer, L. D. Havenhill; secretary, Geo. E. Johnson; additional members of the executive council, Mary T. Harman, E. O. Deere, E. A. White, and F. C. Gates. The nominees were elected by unanimous vote.

The nominating committee extended thanks to the Wichita Chamber of Commerce for the sight-seeing tour, to the Travel Air Company for the privilege of visiting its factory, to Dr. Hazel E. Branch and other faculty members of the university of Wichita for arrangements for the meeting and for the banquet, and to Prof. E. A. White for his long service as secretary.

The auditing committee reported that the accounts of the treasurer were correct.

The committee on library and publications made the following report:

1. That Kansas University is making an effort to properly catalog and house the library of the Academy The library is now partly available for use by the faculty and students of the University and members of the Academy Your chairman found that the University is desirous of retaining the library, and although they are without sufficient room and facilities will do everything possible to make the books of the library available

2 That the continuation of the publication of the Transactions of the Academy is highly desirable and in fact necessary to the life of the Academy The committee, therefore, recommends that the Transacions of the Academy since the last report (Fifty-third meeting, Vol 30, 1921) and including the Wichita meeting in 1928, be published as soon as possible out of the available funds of the society; that any and all papers presented at these meetings be published at the request and the expense of the author This expense may be conveniently apportioned to a certain number of reprints issued to each author

It is recommended that a committee of five be appointed by the president to constitute a publication committee and that one of their number designated as editor; that this committee bring together the minutes of the meetings and those papers from authors who desire them included in the next issue; that, after the material is properly edited and considered, bids for publication be obtained and the committee be empowered to publish this material as soon as possible

3. That the policy of publishing only enough copies for members, abstracting agencies and for sale be established This will eliminate practically all free exchanges. The committee recommends the elimination of exchange publications unless such exchanges can be made to work to the immediate financial advantage of the Academy

4 That all funds of the Academy be spent for the Transactions, after deducting such necessary expenses as postage, stenographic work, and travel allowance, or other expense ordered by the Academy

5. That plans be made by the publication committee as soon as possible for financing the future publications of the Academy and placing the Transactions on a permanent basis This committee recommends the following possible sources of revenue for study and investigation

(a) Increase of dues to $1.50 a year This is undesirable until the available membership at the present dues is proved to be inadequate

(b) Securing a permanent endowment by solicitation of funds from interested residents of the state

(c) By grants from existing state organizations, such as the various educational institutions, State Board of Agriculture, State Horticultural Society, etc.

(d) By securing an annual rental for the use of the Academy's library. The Academy must, however, remember that it has in existence an agreement with Kansas University concerning the library

(e) Sale of the library as a whole or in parts as a source of endowment or of meeting publication

It would appear from information on hand that a creditable publication can be maintained for sums from $100 up, depending on the size of the annual volume, quality of paper and illustrations

It was moved and passed that this report be accepted section by section. After discussion and adoption of the several sections, the entire report was accepted.

A motion was carried to instruct someone to report this meeting to "Science". The president requested the incoming secretary to make this report.

The reading of papers followed. Later in the forenoon a few minutes were devoted to business.

The Kansas Entomological Society through R. L. Parker, its secretary, presented Article I of its constitution for the consideration of the Academy. This article reads:

"The name of this society shall be the Kansas Entomological Society This society will be affiliated with the Kansas Academy of Science without dues of the society to that society."

The article was approved by the Academy.

Dean Willard of the Kansas State Agricultural College invited the Academy to hold its 1928 meeting at Manhattan and the invitation was accepted.

By motion it was voted to shorten the papers to enable the Academy to adjourn by 12:30. The reading of papers was resumed. The Academy adjourned at 12:25.

President-elect Wooster called a meeting of the new executive council immediately after adjournment. In consultation with the retiring president he appointed the following publication committee: G. E. Johnson, Roy Rankin, M. T. Harmon, W. J. Baumgartner and F. C. Gates.

E. A. WHITE, Secretary

Report of the Treasurer

April 14, 1927, to April 13, 1928

Receipts:	
Balance brought forward	$153.22
Collected from A. A. A. S. members	66.00
Dues from members	28.50
Interest on deposits	4.00
Total receipts	$251.72
Expenses:	
Deposit with cashier K. U.	$ .89
Stamps and post cards	23.75
Traveling expenses, President Harman	5.62
Programs (500)	8.00
Stenographic work	30.00
Total expenses	$62.26
Cash on hand April 13, 1928	$183.46

L. D. HAVENHILL, Treasurer

PAPERS AND ABSTRACTS

From Fifty-fourth Annual Meeting (1922) to the Sixtieth Annual Meeting (1928) Inclusive

Kansas Grown Digitalis

Abstract of Paper 38 of the 1926 Meeting at Winfield

L. D. HAVENHILL
University of Kansas, Lawrence, Kansas

Digitalis, one of the most reliable of heart tonics, is being successfully grown in the Drug Garden at the University of Kansas. The plant appears to thrive under cultivation. The seeds must be germinated in the greenhouse and the young plants transplanted in early spring. The following analytical data is presented:

Average yield of fully developed green leaves per plant	142 Gm.
Upon drying this weight was reduced	83.43%
Giving an average yield of air dry drug of	16.57%

The analysis of the air dry drug was as follows:

Moisture	6.28%
Ash	17.65%
Insoluble Ash	6.54%
Fat removed by Benzin	3.13%

Biological Assay showed an activity of 160% U. S. P. standard. The acid insoluble ash is higher than the U. S. P. standard of 5%, but the assay shows the drug to be 60% above the U. S. P. standard of potency.

The result of this investigation shows that Kansas grown digitalis is a superior product. The work is being continued and it is planned to grow four hundred plants this season.

Notes on the Chironomidae of Kansas

Paper 12 of 1928 Meeting at Wichita

HAZEL E BRANCH

Unversity of Wichita, Wichita, Kansas

At Manhattan in 1925, we read a paper on the specific differences in the egg masses of Chironomidae* and showed a number of photographed masses.

We have in mind the preparation of a key if this egg mass character proves to be valid. Last spring we had an experience which tested this validity for one species and it held true.

While visiting the State Fish Hatchery at Pratt, Kansas, with a class in vertebrate zoology, some of the class became interested in the "gnats" above a pool and called attention to them. These insects were chironomids and therefore we collected a few and brought them home. In looking over the catch that evening we felt reasonably sure that the chironomid was Chironomus cristatus but the species had no valid record for Kansas.

As there were three females in the lot, we put each into a clean test tube with about one cubic centimeter of water in the bottom. This was the system we had used in former experiments and knew that Ch. cristatus would lay an egg mass under such conditions. In the morning we were rewarded with three egg masses which were beyonnd a doubt the egg masses of the species. We reared the larvae and these fulfilled all the character requirements.

In order to further confirm the classification, we sent the females that had laid the egg masses and a male collected at the same time and place, to Dr. O. A. Johansen of Cornell University who classified them as Chironomus cristatus.

This observation shows (1) that the egg mass character is valid for Chironomous cristatus Fabricus, and (2) that the species is a member of the fauna of Kansas.

* In publication Ann Ent Soc. Am.

Kansas Botanical Notes, 1923-1928

A Summary of Papers 27, 1924; 2, 1925; 31, 1926, 9a, 1927; 10, 11, 1928

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Three buds at a node, instead of two, have been noted in box-elder (Acer negundo), red ash (Fraxinus pennsylvanica), green ash (F. lanceolata), sugar maple (A. nigrum), soft maple (A. saccharinum) and Paulownia tomentosa.

Twenty-six new megasporangiate cones on one new shoot were found on Pinus mugo mughus by Prof. W. E. Davis in 1923.

Three sets of megasporangiate cones on new shoots of jack pine (Pinus banksiana) were first seen in 1923 (Bot. Gaz., 77:340-342. 1924.).

With open winters of 1922 and 1923, castor beans (Ricinus communis) and tomatoes have self-sown themselves and a few clumps of sudan grass remained alive over one winter.

A Japanese bamboo (Arundinaria japonica) at Manhattan is spreading from year to year, but its shoots have never been over 1.4 meters high.

Gametophytes of Equisetum laevigatum were well developed on muddy banks of the Kansas River at Manhattan in the fall of 1923.

Salvia splendens was a splendid frost plant in late Oct., 1923.

The separation layer was slow in forming or was very imperfectly developt in the falls of 1923, 1925, 1926.

In the cold spring of 1924, an unusually small crop of dandelions developt, but there was an enormous crop of seeds of soft maple (Acer saccharium), elm (Ulmus americana) and hackberry (Celtis occidentalis).

Claytonia virginica was found in May 1924 in Ellsworth Co., by G. J. Ikenberry.

Three-winged fruits of green ash (Fraxinus lanceolata) were found in Manhattan by S. Fred Prince.

Perilla frutescens appears to be becoming an objectionable weed in Leavenworth Co.

Vivipary in Bromus erectus was noted by C. O. Johnston.

Aegilops cylindrica is assuming importance as a wheat field weed in south central Kansas.

Much late growth in the fall of 1925, including leafing out of a lilac in December and the swelling of buds of soft maple until seven groups with stamens fully exposed were found and great swelling in elms, maples and cottonwoods to the point of bursting but stopt by cold weather in the middle of December.

From the 106 seeds obtained from two tricotyledonous seedlings of tomato in the greenhouse at Manhattan by R. P. White, no or

only very poor plants were obtained, not one of which was tricotyledonous.

Bromus japonicus appears to be well establisht in the eastern part of the state under many conditions.

Fasciations were noted in dandelion and sweet potato in 1925, in Hymenopappus corymbosus in 1926, in Ailanthus altissima in 1927 and in Asparagus officinalis in 1928.

A great deal of fall growth and the bursting into bloom of shrubs took place in the fall of 1926, including as most noteworthy the flowering of Iris pumila.

Seven-year-old trees of Chinese Elm (Ulmus pumila) came into good bearing in the spring of 1927 at Manhattan.

A comparison of the work of A. S. Hitchcock and others previous to 1900 and of Pearl Maus in 1926-27 in Wabaunsee County, Kansas, brings out the interesting point that 112 additional plants are now recorded in the county, making the county list total 447. Subtracting those recorded in the counties on all sides previous to 1900, leaves 72 species. Of these 38 are introduced species(30 from open country and 8 from woods). Of the 34 new native plants, 5 have come in from the north (1 of which is a plant of woods); 5 plants of open country from the south; 5 plants of open country from the west; and 19 from the east, of which 8 are plants of open country and 11 are plants of wooded areas. Thus it appears that the western migration of eastern native plants is taking place more rapidly than the eastern extension of western plants.

Star-Thistle (Centaurea picris Pall.), a New Weed in Kansas

Abstract of Paper 19 of the 1922 Meeting at Manhattan

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This tufted perennial, about 40 cm. high, with involucral bracts with broad rounded scarious tips and whose margins break up more or less into fine hairs, short linear entire or remotely toothed leaves, a native of the Caspian region, was collected by J. W. Head in Washington county, during 1921. It may well become a serious weed.

Transplantation of Ovaries in the Guinea Pig for Reproduction and for the Endocrine Effect During Pregnancy

Abstract of Paper 5 of the 1927 Meeting at Lawrence
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For more than thirty-five years, ovarian transplantation to test for foster mother influence on the young, has been attempted. The results are so meager, however, that conclusions drawn by various workers are not in agreement.

To supplement the work already done, ovaries were removed from guinea pigs carrying dominant genetic characters and were replaced by ovaries from guinea pigs which were recessive to the genetic characters. The guinea pigs that had received the new ovaries were mated to recessive males. In one case, B18 a black pig, received the ovaries from a recessive red pig and the mating was made with a red male. One red offspring was produced.

A golden agouti, C15, was mated to a recessive pink-eyed, white male after having received the ovaries from a recessive pink-eyed white female. One golden-agouti offspring like the mother was produced. A thorough examination of the one recovered ovary led to the conclusion that all of the original ovarian tissue was not removed at the time of the operation and it regenerated to the extent of producing ova.

There were only two offspring resulting from thirty-eight grafts.

Another phase of ovarian transplantation studied was the relationship between the ovaries and the developing embryos and mother during pregnancy. This problem was approached by removing the ovaries from eighteen guinea pigs that were in almost all stages of pregnancy except the very earliest. Fifteen of the ovariectomized females aborted their young in from one to twenty-three days after the operation. Three gave birth to living young in a normal manner. One of the three was in twenty-seven days of pregnancy when the ovaries were removed after which the young were carried forty-one days before parturition. The others to give birth to living young were in later stages of pregnancy. Eleven of these were examined to determine if the mammary glands were functional at the time of delivery. In nine cases they were functional. In fourteen cases examined, the pelvic girdle had relaxed in every case at the time of delivery.

Fourteen other guinea pigs were selected in similiar stages of pregnancy as those in which the ovaries were removed. The ovaries were removed from these animals and were replaced by ovaries from other guinea pigs. In all but two cases the ovaries were obtained from virgin females which could not contain corpora lutea of pregnancy. Nine of these pregnant females gave birth to living young and five aborted their young.

Conclusions

1. There is no evidence that modification by foster-mother influence is expressed in the offspring.

2. It is very difficult to transplant the ovaries from one animal to another so that reproducion will follow.

3. It is difficult to remove all of the original ovary and regeneration of the remaining fragments may take place.

4. Removal of the ovaries from pregnant guinea pigs causes abortion in the greater number of cases.

5. The presence of an ovary tends to prevent abortion but the active element is not confined to the corpus luteum of pregnancy.

6. Removal of the ovaries during pregnancy does not prevent the functioning of the mammary glands or the relaxation of the pelvic girdle at the time of parturition.

7. When abortion results from the removal of the ovaries in guinea pigs it occurs usually several days after the óperation.

The Economic Value of By-Product Foods

Abstract of Paper 12 of the 1922 Meeting at Manhattan
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In this economic age the utilization of by-products of food has become a necessity, and to the manufacturer and the chemist is presented the problem of preventing waste. In some industries in fact it is stated that no profit is made from the main food products placed on the market, but that he profits must come from the saving of the by-products. A few suggestions as to what has already been accomplished can only be mentioned here.

In the meat packing industry those by-products saved for consumption are the head, heart, tongue, liver, intestines, brain, fat, bones, feet, and hair; and, not least important, all materials not otherwise used are made into fertilizers. Fish by-products made are caviar, isinglass, glue, and oil for industrial and edibile uses. Cottonseed, which formerly was thrown away, or even disposed of at some expense, is utilized for making salad oil which when hydrogenized is used for cooking and in the manufacture of butter substitutes; the "linters" are used in manufacturing felt, and the "press cake" may be ground and used as stock feed or as a fertilizer. Corn oil, has become a valuable material which is utilized as a salad oil, or in butter substitutes, and the refuse is valuable stock feed.

The soy bean contains twenty per cent of a bland oil which is used all over the world. Two hundred milliion pounds are annually imported into the United States. Some of it is used in food, and the lower grades in soap and paint manufacture. Other "oil-bearing" seeds are used as a source of oil in different countries, as the sesame, poppy and hemp in Europe, the sunflower in Russia, and tomato seeds in Italy. Apricot kernels, peach kernels and mustard seeds yield excellent oils.

In vine-growing countries, not only is the fruit juice used for making grape juice and wine, and the fruit for making raisins, but the wine when it has fermented sufficiently, deposits "Argols" or acid-potassium tartrate, which when purified yields Cream of Tartar, and Tartaric acid, used in making baking powder. The refuse from the wine press, when burned, yields potassium carbonate, valuable as a fertilizer.

In the citrus industries, the "culls", or unripe and imperfect fruit, which not so long ago was gotten rid of with difficulty, are now utilized at a considerable profit. From the oranges come orange oil, dried orange peel, concentrated pulp, which is the basis of numerous orange beverages, and more recently a white, dry pectin which is used in making jelly from fruits which are wanting in that material. From the lemon, in addition to the oil and pectin, citric acid and calcium citrate are obtained. The waste products in this industry are dried and used in the manufacture of chicken feed.

Casein, from skim milk, used in making buttons and in various industries, and milk sugar, are valuable by-products in the dairy industry. Sugar is not the only useful product from the sugar-cane, for the final molasses residue known as "black-strap" is a valuable stock food. The spent bone black used in the purification of the cane juice is used for making shoe blacking, and from the "Bagasse" or crushed cane a very useful insulating building board or an insulating material may be made. In the roasting of coffee, the alkaloid caffein in small quantities is driven off and collects in the flues. This is later purified and is used in various popular carbonated beverages.

This list is only suggestive, for there are numerous other by-products that have been or may be utilized, and it is the task of the chemist and the food manufacturer, to practically apply their knowledge to our food supply, and thus effect a great saving.

Some Needed Reforms in Packing of Food Products

Paper 4 of tthe 1923 Meeting at Lawrence

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University of Kansas, Lawrence, Kansas

To one who has been associated, almost from the beginning, with the reforms that have been made in the campaign for furnishing pure foods to the consumer, it is interesting to watch the evolution of a label to the point where it tells "the truth, the whole truth and nothing but the truth". This label is coming and in fact has almost arrived.

Previous to 1906, when the Federal Food and Drugs Act was passed it was evidently not considered "good form" for a label on a food container to tell the truth. A "strictly pure" spice meant cracker dust flavored with pepper, allspice, or cloves, as the case may be. "Pure Vermont maple syrup" with an elaborate cut of a "Sugar Bush" meant cane sugar flavored with an extract from maple bark and corn cobs. "Grape crystal baking powder" with a cut of a luscious bunch of grapes (because tartaric acid is made from the argol of grapes) meant just an ordinary alum baking powder. "Pure strawberry jam" meant a mixture of some fruit juices, perhaps that of the apple, colored with a coal tar dye, sweetened with glucose rather than cane sugar, flavored with synethic flavors made in the chemical laboratory, preserved with sodium sulphite and transformed into strawberry jam by the simple admixture of a sufficient quantity of grass seed. The so-called "condensed cream" was concentrated skim milk. "Hamburg steak" was made of the ancient scraps of beef left in the market, kept in a state of perennial youth, not by the use of the lip-stick, so effectually used in some circles at present, but by an abundant sprinkling of the preservative sodium sulphite, which makes steak look red and fresh. Oysters were "fatted up" by being soaked in fresh water: "Genuine olive oil from Lucca,

Italy," with an Italian label, was manufactured in New York from cotton seed oil. These are but examples of the condition of food markets at that date, but times have changed and now the manufacturer must take the consumer into his confidence, and tell him what the package contains. Even the elaborate pictures which, while not stating in so many words an untruth, psychologically conveyed a false impression, have been discarded. Foods that were adulterated with injurious or poisonous substances were the first to go in the cleaning up of the store or the wholesale house or the pantry, because public opinion would not stand for that, however much the people were willing to wink at prevarications on the labels.

Then came the trouble with the weight of food packages. It was persistently stated that it would be unfair to the manufacturers to require the actual weight to be stated on the package. It was not until the passage of the Federal Net Weight Law, that the actual weight of the contents of the package was unblushingly told to the consumer. Even then, there was a disposition to evade the law, as for instance in the dairy industry. Here the butter factories began to put on the market a package of butter weighing fourteen or fifteen ounces. If the consumer complained that he was not getting a pound, the dealer replied "No, we did not sell you a pound, that was only a carton", and "you will notice that the weight is stamped upon it". It was nevertheless a fraud on the consumer for the fifteen ounce carton was what was supplied when a pound of butter was ordered. This practice became so common that legislation was required to stop it, and now our package contains a pound of butter.

But the trouble was not over even then, for water has always been cheaper than butter fat and so the makers allowed more than the legal maximum, 15.99% of water to remain in the butter after it was worked. Not until this kind of butter was declared to be adulterated and, as such, liable to a special revenue tax, was that game stopped.

We are still confronted with many labels that are just within the law. They do not really make wrong statements but leave the consumer to get a wrong impression. One by one, these labels are being discarded.

There is still one of these abuses that should be corrected: that is the selling of packages of food weighing less than a pound, but with the label bearing truthful statement as to the weight of the contents. This is not a carton exactly, but it is an arrangement by an additional six to ten per cent may be made on the sale. To illustrate: why does the packer of a variety of California raisins put on the market a fifteen ounce package on which it is stated that fifteen ounces are contained, instead of a good full honest pound? Psychologically, the short weight package goes. It takes the place of the pound in the order that you 'phone to the grocery. The price paid is no doubt as much as you would pay for a pound. The public is mulcted one ounce of raisins and the packer gets one

hundred thirty-three more packages than he otherwise would out of a ton of raisins. Some other common package foods weighing less than the pound or aliquot part of a pound, are: seedless raisins, fifteen ounces; currants, seven or eleven ounces; evaporated milk, fifteen ounces; condensed milk, another brand, fifteen ounces; macaroni, seven ounces; another brand of macaroni, seven ounces; baked beans, eleven ounces; and so on. The same tendency to pack liquid food products in less than ½ pints, pints, or quarts, exists.

It is very satisfactory to note that probably nine-tenths of the packages containing foods are of full weight or an aliquot part of the full pound. It is hoped that public opinion will press so hard on a few of these manufacturers that are still not in line, that they will join the majority. Some packers have tried to avoid the embarrassment that follows the discovery that their packages are not up to full weight, especially in foods that are liable to lose weight in drying, by the statement, "this package was of full pound weight when packed", but that is rather a dangerous statement, certainly liable to lead to complications. A reasonable variation from the stated weight or measure of products is allowable, but this variation should be as often above as below the quantity stated.

Water Solubility an Economic Force

Paper 26 of thte 1925 Meeting at Manhattan

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The geologist will tell you that erosion is one of the great forces that has been used to shape the earth into its present form; that it has entirely transformed the surface; that it has cut out mighty valleys, has scoured away mountain ranges, covered the plains with fertile soil and extended the surface of the continents far out into the sea. This is all true; the water-borne detritus has accomplished wonders. Without the aid of this erosion but a small portion of the surface of the earth would be habitable—the waving fields of grain would never have been possible.

While erosion in the geologic ages long past, was doing this, something else was going on, for the agent that did this stupendous work, was also a solvent. Water is not by any means the only solvent, although it has been called "the universal solvent", but it is possessed of this property to such a wonderful extent that the secondary results of the erosion are of the utmost importance.

In the process known as "levigation" the artisan reduces his material to an impalpable powder by grinding with water. In this way the graphite and the clay used in making the different grades of lead pencils are ground with water, day after day in a kind of mortar, to bring them to the desired condition of impalpable dust. So also, the rocks and gravel and sand have been ground together, in this process of erosion, as they have been hustled down the mountain sides, and as the pieces become smaller, the surface of

the mass has been increased, and the opportunity for the solvent action of water has by tthe same measure been increased.

Contained in this mineral material that the waters have carried by gravity to lower levels, are the mineral substances of which the crust of the earth is composed, and these materials are not like so much sand—good for scouring and nothing else—for the water immediately, as soon as it gets into contact with the load which it has been comissioned to carry down the valleys, begins to attack it, and to dissolve minute quantities of the material. To its aid, in this task comes the carbon dioxide of the air as a sort of an accomplice to help boost in the process.

Thus the lime, the magnesia, the sulfates, phosphates and chlorids, and particularly the compounds that the still more soluble—namely the sodium and potassium minerals begin to disintegrate. Even such a seemingly stable material as feldspar—a silicate of potash or soda, lime, aluminum, iron, and magnesia, begins to fall to pieces for the water has dissolved the more soluble ingredients.

Though the water may have started from the clouds, and struck the earth on the mountain top, in almost virgin purity, it soon begins to show traces of the mineral substances that it has picked up in its race towards the sea. When this water soaks into our wells, we call it hard water, because it haas absorbed so much mineral matter in its journey which it will not readily give up. By a process of evaporation the water may be induced to leave a part of its newfound companions in a soluble form in the soil, but the mineral materials will never wholly desert the water. They are there to stay. Only from a saturated solution will the mineral salts crystalize out.

It has sometimes happened that this mineral-saturated water collects in a depression in the earth. It cannot escape by any river or other outlets. More water also soil-saturated comes in—this process continues for centuries, and as some of the water, tiring apparently of its association with the baser mineral matter, allows the sun to pick it up, and carry it away in fleecy clouds, the lake, as we now recognizes it, becomes more fully saturated with mineral material—with the more soluble of the minerals of the earth's crust—and finally we have a SALT LAKE. Let the process go still farther, until all the wter is evaporated, and a bed of mineral matter remains —a bed of rock salt perhaps. This is ultimately covered with detritus, the result of further erosion and a salt bed deep below the surface is formed.

We left the rivers, carrying with the suspended material their load of soluble material to the sea. Here again the process of concentration goes on—so that finally all the elements, a little of each in proportion to their solubility, are stored in the ocean. Some organic material goes along with mineral matter but the low forms of plant and animal life are awaiting the arrival of this refuse from the land, and utilize it in their growth. The higher forms of animal life feed

on these lower organisms, so the total organic life does not increase, as do the mineral constituents of the sea.

What is really but a drop in the bucket, is the addition to the ocean of all the sewage, and refuse, of the cities along the shore, The great fishing banks along the shore of New Foundland, and in the English Channel, are but illutrations of the way in which this organic matter is taken care of in the feeding of the vegetable and animal life of the sea.

What a wonderful sanitary agent is the salt sea, twice every 24 hours it flushes out the slips, and docks, and sewers, of a great city. The sea is after all but a slave of the sun and moon. It would be difficult to compute the quantity of refuse that in a much more efficient way than any garbage commission could ever accomplish the work, is thus daily taken care of by the sea.

Going back to our mineral-saturated, or partially saturated streams, that have poured their load into the salt water, let us ascend to their sources. On the mountain sides, in the valleys, beside the streams, we find the beginning of the so-called "mineral waters". The water has percolated into some deposit of lime or magnesium carbonate, some iron deposit, some sulfurous, cavern, and comes to the surface bringing its load of mineral material. This is the mineral spring or saline well. Perhaps the water was under pressure down there; if so it may have come to the surface sparkling with carbon dioxide gas, it is an effervescent water. If this hidden source is filled with decomposing sulfur and iron compounds, the whole air of the country side is scented with the fumes. Invalids flock to these sulfur springs for rejuvenating and healing baths.

If, on the other hand, the water has flowed over quartzite, or granite or even a trap rock, it has not been able to pick up much mineral matter—it is a pure water, adapted for use as a "table water" like the Poland Springs of Maine. It is however a valuable therapeutic agent, for frequently all the patient needs is plenty of pure water, to flush out the system.

Aside from the therapeutic action of mineral waters, which it is not our purpose here to discuss, the soluble materials originally picked up by the waters, and often again deposited, are of the greatest importance in our economic life. Consider, for instance many of the copper deposits, especially the carbonates; they were evidently at one time in solution, and when conditions of evaporation heat or pressure changed these copper salts were deposited as veins of ore, which later became covered with the weight of mountains of other rock perhaps, but this, when discovered and utilized by man, becomes an important copper mine. The same thing is true of iron, for many of the most important iron ores, show their aqeous origin. The iron was once in solution in water. This is especially noticeable in the carbonates and oxides such as limonite, siderite and even the very abundant oxide of iron known as specular ore. The same conclusion as to its origin, must be reached if we ask where the zinc carbonate comes from, or perhaps also the common

sulfide or zinc blende. You say that we do not find often now-a-days mineral springs, containing copper or zinc; this is true, but the conditions are so different now from what they were in the earlier ages, when the surfce was being worked over more than at present, and before the gigantic upheavals of the mountain ranges, took place.

The limestones have been deposited by the action perhaps of the minute aquatic organisms or crustacae, but the lime was first brought into solution, by the water, before the minute organisms could utilize it, and the same thing is true of magnesia. It may seem a long time since the Carrara marble was in solution in the waves that dash against the Mediterranean shores, or since salt water was near enough to the Vermont Marble quarries to furnish the lime for the construction of the rock, but we must recognize the aqueous source of all this material.

Scattered about in large areas in different parts of the country, far away often from the present ocean shore, are great beds of gypsum so important as a source of fertilizer and for the making of plaster of Paris. We do not attempt to say how long it is since the material of these beds was in solution in the surrounding waters but it was there, and we must acknowledge the source. The same thing is also true of the Barites deposits, of the potassium and magnesium and soda salts of the Strassfurt mines in Germany and the phosphate beds of the Carolinas.

When the aluminum manufacturers looked about for a material suitable for making the metal, which now has become almost indispensable for the manufacture of cooking utensils, aluminum bronze, or for some strong, light material for the frames of aeroplanes, they chose bauxite, the clay-like aluminum iron hydroxide, because it was readily adapted for smelting in the electric furnace. It is true that feldspar was a much more abundant, and a cheaper rock containig aluminum, but it has not been found practical to use in the aluminum furnace. No doubt the elements of bauxite, originally occurred in feldspar, or other minerals found in the granite rocks, but it had to be taken out by water and concentrated, so to speak, in the form of a simple oxide before it was available.

Numerous other illustrations of this kind might be cited, but they all point to the tremendous importance of the work of the water in adapting the earth for the use of man, which has occurred coincident with the grinding and disintegrating action of erosion.

An Analogue of the Cupric-Ammonia Ion in Acetic Acid Solution

Abstract of Paper 37 of the 1927 Meeting at Lawrence

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Cupric acetate dissolved in glacial acetic acid may be considered as analogous to cupric hydroxide in aqueous solution, the solute having in each case the same anion as the solvent. The solubiltiy of cupric acetate in acetic acid is small, the saturated solution having a bluish green color. When ammonium acetate is added, the solubility of the cupric salt is greatly increased, (as in the corresponding case of cupric hydroxide and ammonium hydroxide in aqueous solution), and the color of the solution changes to blue. Even more striking is the fact that on heating the solution of cupric acetate and ammonium acetate in acetic acid, its color deepens and also changes somewhat toward the violet, until it becomes practically identical with that of an aqueous solution containing the so-called cupric- ammonia ion.

Either this similarity in color is entirely fortuitous, which seems improbable, or else the color of the acetic acid solution is to be regarded as being due to the presence of cupric-ammonia ion, which at first sight appears unlikely also, since this solution contains a large excecss of the acid. But as a matter of fact it is entirely possible for free ammonia to be present in acetic acid solution at elevated temperatures, just as it is in water, to a considerable extent, at ordinary temperatures; and ammonia can be distilled off along with acetic acid from such solutions. It was shown experimentally, for instance, that a solution containing 75 grams of acetic acid, 25 grams of ammonium acetate and 2 grams of cupric acetate began to lose ammonia at 135° to 140° C. (as indicated by the presence of a perceptible quantity of ammonia in the distillate collected between these temperatures). At 135° C., also, the color of the solution exactly matched that of an aqueous solution containing the cupric-ammonia ion.

It is, then, altogether reasonable to conclude that the deep violet-blue color of such a solution is due to an ion very similiar in its nature to that which give rise to it in aqueous solutions. The problem is being studied further in this laboratory.

Extension of the Natural Range of Two Mammals in Clay County, Kansas

Paper 25 of the 1925 Meeting at Manhattan
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The north-western part of Clay County was settled mainly in the years 1869 to 1871, and before 1872 there was little broken prairie on the upland. In the early days there were large mammals which are now either extinct or very rare, like the beaver and members of the deer family. Some mammals, however, not only hold their own but are actually more numerous in the present civilized environment than formerly. Among these is the jack rabbit. The coyote would be in the same category were it not for the continuous efforts being made for its extermination by special bounties, wolf-hunts, and the like.

Two mammals are now in the region which entirely unknown in the early days, the prairie dog, (Cynomys ludovicianus Ord.) which originally did not extend eastward much if at all beyond Concordia, and the opossum (Didelphys virginiana Shaw).

The prairie-dog is a short-grass animal. The development of well grazed pastures, the constant increase of the buffalo grass and the mesquite grasses and the grazing down of the tall Andropogons, have extended the ideal conditions for the home life of the prairie-dog to the eastward. A large colony of prairie-dogs was started about twenty years ago in a large pasture in Bloom township, just west of a farm owned by the writer. This dog town is on Section 12, town 7, range 1 east. The prairie-dogs spread for half a mile in spite of desultory attempts to eradicate them. They moved southeast from the original center down a long slope and a large ravine, until, at the end of the pasture they came to the tall grass Andropogon furcatus Muhl., on the writer's farm which was not pastured (Section 7, town 7, range 2 east). They stopped short here and for years never invaded it although they spread northward along the pasture fen_e for a third of a mile. Occasionally some adventurous pioneer would move across into the edge of the long grass, dig a hole, and make a small clearing, but invariable this site was abandoned to the great relief of the writer who watched this performance for ten years. In the meantime the "dogs" did not hesitate to mow off several acres of small grain each year to the south. Recently, in 1923, a determined attempt was made to exterminate the "town" and in the summer of 1924 only a few of the hundreds of mounds which had living inhabitants remained. The writer was also informed by competent persons that prairie-dogs had invaded some of the large pastures farther south in the county. But the writer did not see these.

The opossum is now quite common all through the region while in the early years the writer never heard of one being seen, although

racoons and badgers were frequently taken by him and others. Its original range in the region probably did not extend farther than the southeastern part of the county where oaks are still common. The writer long ago heard his father say that the opossum was present in the south eastern part. The progress of the opossum toward the northwest is probably due to the much more certain food supply under civilized conditions. There is corn part of the year, to say nothing of poultry and eggs, especially in the fall and winter when food must have been exceedingly scarce for the opossum in a region where acorns and other nuts and fruits are absent. Unlike the prairie-dog which is sure to be eradicated sooner or later, the opossum will probably enjoy the blessings of civilization for a long time to come.

Primary Forces

Paper 23 of the 1926 Meeting at Winfield
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Were gravitation and the other attraction forces suddenly to become inoperative, the form and movement of world materials would undergo remarkable changes; planets, molecules, atoms, electrons and protons would suddenly disintegrate and, in time, the universe would become a homogenous mass of infinitely small particles.

It can be shown, however, that such a choas would again take form and revert to the present condition; that an infinite number of unthinkably small, elemental particles flying through limitless space in every conceiveble direction would lead to the birth of universal gravitation, the accumulation of nebulae, the building of protons, electrons, atoms, and molecules, the shaping of worlds and the formation of the thousands of compound substances known to present day scientists.

Let us suppose that, "in the beginning", the universe consisted of an infinite number of extremely small particles. We must not assume that they would be all of the same size. It would be a remarkable coincidence were such the case. Let us see what would happen if they differed in size.

First, considering the speed of a single particle relative to any other, there would be but one chance out of an infinite number that two such particles would be relatively at rest, (i. e. both moving in the same directioon and at the same speed) and there would be one chance out of an infinite number that the relative speed would be infinite. Between these two extremes, each and every conceivable velocity would have an equal chance so that the average velocity of any one particle, relative to that of any other, would be infinity divided by two. This, for all practical purposes, would be infinity.

Our problem, then, is this: Find the result of an infinite number of particles, differing in size, darting through the universe at infinite speed.

It will be seen that any particle, larger than the rest, would be bombarded by the smaller ones on all sides, but that two such larger particles would protect each other somewhat from such bombardment on their facing surfaces, thus being driven towards each other. The force driving them would vary inversely as the square of their distances apart, but not as the product of their masses. It would vary as the square of their diameters, or as their surface areas.

In this way, each larger particle would tend to approach each and every other larger particle in the universe. It can be shown that such particles would form clusters resembling our own Solar system and still larger groups resembling our steller system. It

can also be shown that, were our stellar system compressed between two huge flat-irons, into the shape of a sheet of paper, it would retain that shape, after a time, even though the flat-irons were removed.

Now let us suppose that a sheet of writing paper is constructed much after the fashion of our stellar system, being made up of electrons, protons, molecules and groups of molecules just as our stellar system is made up of planets, suns, solar-systems, and groups of solar-systems. Would such a sheet of paper act as paper does act at present? Let us see?

Were we to lay such a sheet of paper upon a scale for weighing, the Earth would protect it from bombardment of fine particles from below. The particles bombarding the paper from above would drive it against the scale with a force of say 20 dynes. How is it, then, that two such sheets of paper would be driven against the scale with a force of 40 dynes? The paper surface has not increased, you may say, and so the weight should be but 20 dynes regardless of the number of sheets. Well, this is the solution:

Such a sheet of paper is not the solid it seems to be. It is composed of molecules which, in turn, are built up of atoms. The atoms are formed of protons and electrons and even these smaller units are probably composite. Such a sheet of paper highly magnified would resemble our stellar system. Through such a sheet practically all of the bombarding particles would pass unhampered. This means, of course, that practically as many bombarding particles would pass through the second sheet as through the first and practically the same number would bombard the larger particles in the second sheet as in the first, causing each sheet to be driven with equal force against the scale. If this theory of matter be true it can readily be shown that masses will be driven toward each other with a force which will vary directly as the product of their masses and inversely as the square of the distances between their centers, except in the case of extremely small masses and extremely large masses.

A little figuring will show that even our Sun would allow practically all of the bombarding particles to pass directly through it. For this reason the Moon's attraction for the Earth would not be measurably less during a total eclipse of the Sun.

Thus the theory of "Primary Forces" can be made to account for gravitation, which seems to be instantaneous in its operation. In time it may be made to account for the heat of the Sun as due to the bombardment of the Sun's inner mass. It may even account for the Comet's tail which always points away from the Sun as probably due in some way, to the stream of bombarding particles which have passed through the heated Sun and then through the comet. Atomic energy may be due to the activity of the particles bombarding atoms; the latent energy of suspended weights is readily explained; and even the latent energy of the bent spring can be understood in terms of bombarding particles.

If the theory should prove to be true it is just possible that all phenomena may be explicable in terms of bombarding particles. For instance, such bombardment may cause the explosion of composite units within electrons and thus set up an internal pressure which increases until it more than counterbalances the pressure of bombarding particles from without. Such exploded units would not escape through the surface uniformly at all points but would leave in greater numbers wherever the external pressure was least. Thus, the facing surfaces of two electrons in close proximity, being protected somewhat from bombarding particles, would have a lessened external pressure. The exploding particles from within would stream out through such facing surfaces and drive the electrons apart. Two protons may repel each other for similar reasons This explanation is not wholly satisfactory but may lead to something better.

In applying the theory of "Primary Forces", however, it should be realized that the situation is not so simple as it has been described. Some of the bombarding particles may, in themselves, be systems of smaller particles held together by still smaller bombarding particles. In searching for the ultimate, indivisible particle we may be hunting the end of the rainbow.

A state of rest in the Universe might be defined as the average motion of all of the bombarding particles. All larger masses would tend to acquire this average motion just as a balloon tends to float with the wind. Thus it is that stars are relatively at rest or nearly so as compared with the infinite speed of the particles causing gravitation. While the fixed stars represent the average or balance of the motion of bombarding particles, yet this is not necessarily the same in different parts of the universe. Drifts and eddies may occur in the great flow of bombarding particles. Again, as sand grains are sorted as to size or weight by the varying velocities of a stream, so the bombarding particles which are composite may be assorted somewhat as to size and banked in different parts of the universe.

Many strange phenomena are sure to arise which could not be accounted for merely by assuming a theory of bombarding particles in its simplest. form. There seems to be a striving toward more and more complex organization and it may be that this striving, although necessarily deterministic, is accompanied by consciousness. It may even turn out to be true that mind and energy are synonomous terms. Evidence seems to be pointing in that direction just at present.

Heat as a Factor in Producing Abnormalities During Incubation in the Chick*

Paper 28 of the 1922 Meeting at Manhattan

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I. INTRODUCTION

Alsop ('19) found that only a small variation in either direction from the optimum temperature during the incubation of the egg produced abnormalities in the central nervous system of the chick embryo. A little earlier the writer (Harman '18) showed that these abnormalities were in two distinct regions, the brain and the distal half of the spinal cord. Miss Alsop showed that when the temperature was below optimum the greater number of abnormalities was in the spinal cord region, but when the temperature was above optimum the greater number of the abnormalities was in the brain region. She further showed that 6.5 per cent abnormalities occurred in controls, and that a variation of more than five degrees from the optimum temperature produced a high percentage of mortality. Her experiments extended only through the third day of incubation. The following experiments have been an attempt to verify Miss Alsop's results and to carry the work through later periods of incubation. Only the conditions of incubation, the distribution of heat and their effects upon the mortality of the embryo are given in this paper.

II. THE EXPERIMENTS

Two types of incubators were used. The first were two incubaters obtained from the Poultry Department.** These were the kerosene incubators used for class work in incubation. The second type of incubator used was the medium sized electric incubator manufactured by the Chicago Surgical & Electrical company.

1. The Experiments with Kerosene Incubators

The incubators were heated by kerosene lamps and regulated as for class work. The egg trays were removed and a thermograph was placed to one side in each incubator. On the other side was a wire basket which contained the eggs during incubation. Five tests were made, varying in length from two to five days. These tests included running at low temperatures, running at high temperatures, and a change in temperature after the beginning of the period of incubation. In all cases the results were in accord with Miss Alsop's

*Contribution from Zoological Laboratory, Kansas State Agricultural College, No. 101.

**The writer wishes to express her appreciation for the cooperation of the department of Poultry Husbandry and their helpfulness in making it possible for her to secure eggs of a high percentage of fertility.

results. In one case when the temperature was 108° F. there was a hundred per cent mortality. The low temperature did not produce many dead embryos nor was the percentage of abnormalities so great.

Later two experiments were tried during which an attempt was made to run the incubators at 103° F. One incubator ran for four days and the thermograph showed a variation of less than one degree during the time. Two dozen eggs incubated during this time gave four normal chicks, eighteen abnormals, and two infertile eggs. This puzzled us greatly for it did not seem to be in accord with the other experiments which we performed. The other incubator was run for four days, but on the afternoon of the second day the thermograph record showed a drop of three degrees, but within three hours it was back to 103° F. During the remainder of the time there was less than a degree variation from the optimum temperature. The two dozen eggs in the incubator during this time showed three normal embryos, seventeen abnormals, and four infertile eggs.

We then put a thermometer in the incubator along with the thermograph, and found that the thermometer on the floor of the incubators registered four degrees lower than the thermograph. This caused us to try another experiment.

We placed three wire trays in the incubator, one on top of the other, allowing a distance of about two and a half inches between the bottoms of the respective trays. We placed a dozen eggs in each tray and a thermometer at the level of the top of the eggs in each tray. The thermometer of the middle tray was on the same level as the sensitive part of the thermograph. These thermometers had been tested previously against one another. The experiments were carried on for three days. The thermograph record showed a variation of less than one degree. The middle thermometer registered not more than half a degree variation from 103° F, at any time during the three day period. The thermometer in the lower tray was 98.5° F. to 99° F., and the thermometer of the top tray registered 107° to 107.5° F. Eight of the eggs in the middle tray contained normal embryos, and four eggs were infertile. There were nine abnormal embryos in the lower tray and three infertile eggs. In the upper tray were three abnormal embryos, five eggs which seemed to have developed only a blastoderm and then died, and four infertile eggs. This same experiment was repeated twice with similar results. Thus it was found that in one incubator there could be optimum temperatures, above optimum and below optimum. We then decided to try the electric incubator.

2. The Experiments With the Electric Incubator

For the first experiment in the electric incubator the tray was charted to hold twenty eggs. These eggs were numbered and were kept in the same place in the incubator during the entire period of incubation. A thermometer was placed in the center of the box so that the bulb was about two inches from the top of the eggs in the center of the tray. Another thermometer was placed on the eggs

so that the bulb was at the north end of the tray between eggs No. 6 and No. 11. A third thermometer was placed so that the bulb was in the southwest corner of the tray on egg No. 20. A fourth thermometer was placed so that the bulb was on egg No. 1 in the northeast corner of the tray. These thermometers were read three times daily, and the experiment was continued for twenty-three days. Table I shows the variations in the respective thermometers and chart I shows the results of the incubation.

CHART NO. 1.

4 Apr. 9 Near to hatch- ing, but dead Egg one	Apr. 9 Dead About ten days' develop- ment Egg two	Apr. 9 Dead, but near to hatch- ing Egg three	Apr. 8 Only a blasto- derm Egg four	Apr. 8 Near to hatch- ing Alive and breathing Egg five
Apr. 8 Merely traces of develop- ment Egg six	Apr. 9 Six or seven days' develop- ment Dead Egg seven	Apr. 9 Dead About eight days' develop- ment Egg eight	Apr. 9 Dead, near to hatching Egg nine	Apr. 8 Dead About five days' develop- ment Egg ten
2 Apr. 9 Dead About four- teen days' development Egg eleven	Apr. 9 Dead About four days' develop- ment Egg twelve	1 Apr. 9 Dead About five days' develop- ment Egg thirteen	Apr. 8 Dead About six days'develop- ment Egg fourteen	Infertile Egg fifteen
Apr. 9 Near to hatch- ing Dead Abnormal right foot Egg sixteen	Apr. 9 Dead About eight days'develop- ment Egg seventeen	March 24 Alive Six days' development Egg eighteen	Apr. 9 Dead About nineteen or twenty days'develop- ment Egg nineteen	Broken on second day of incubation 3 Egg twenty

An examination of chart I shows one infertile egg, one egg broken early in the experiment, sixteen dead embryos of widely different degrees of development, and one chick alive and breathing after being incubated twenty-three days. One egg was opened after seven days of incubation. The embryo was alive with a slightly retarded development. An external examination did not show abnormalities. The chart further shows the location of the bulbs of the thermometers with reference to the eggs in the tray. The numbers indicate the number given the thermometer for the sake of recording. The temperatures were read three times daily with a few exceptions which are given in the accompanying table.

TABLE I

Date	Hour	Temperature 1	2	3	4
March 17	9:30	108.5	102	104	102
	11:30	109	102.5	104	102
	3:30	103-	104	105	103
March 18	8:25	109	102.5	105	100
	12:55	101	104	100	98
	8:15	102	100	98	96
March 19	8:10	104	104	100	97
	1:00	104	100	100	98
	6:00	104	100	100	98
March 20	8:00	104	99.5	101	98
	1:00	104	99.5	100	98
	4:00	103.5	99.5	100	97
March 21	10:00	104	102	101	99
	3:00	104	100	100	98
March 22	8:15	104	102	101	99
	12:45	104	102	101	99
	5:00	104	102	102	100
March 23	8:20	105.8	102	103	100
	1:00	105.8	102	103	100
	5:30	105.8	102	103	100
March 24	8:40	105.8	102	102	100
	11:30	105.8	102	103	100
	4:00	105	101.3	102.5	99
March 25	8:00	104	100	102	98
	1:00	104	100	102	98
March 26	8:00	104	99.5	100	98
	1:00	104	99.5	99	97
	6:00	104	100	100	98
March 27	8:00	104	100	100	98
	2:00	104	100	100	98
	6:00	104	97	98	98
March 28	1:30	104	100	99	98
March 29	8:00	105.8	100	100	99
	12:45	104	98.6	98	96
	5:00	104	96.8	99	97

TABLE I (continued)

March 30	9:00	104	98.6	100	99
	1:00	107.4	98.6	101	100
	5:00	107.4	98.6	102	100
March 31	8:45	107.4	104	100	101
	1:00	105.8	104	100	101
	4:15	106.7	104	100	100
April 1	8:45	105.8	102	100	99
	6:00	105.8	102	100	99
April 2	8:00	106.7	104	101	100
	12:35	106.7	104	101	100
	5:00	107.4	104	101	100
April 3	9:30	105.8	102.2	99	98
	2:00	105.8	102.2	99	98
	3:30	105.8	102.2	99	98
April 4					
April 5	8:30	104	100	98	96
	12:40	102.2	100	97	96
	4:00	102.2	99.5	98	96
April 6	8:30	105.8	100	99	97
	11:00	105.8	100	99	98
	3:10	105.8	100.2	100	98
April 7	8:15	105.8	100	99	98
	1:15	105.8	100	99	97
	5:00	105.8	100	99	98
April 8	10:00	105.8	102.2	101	100
	2:55	105.8	100	101	100
	5:00	105.8	100	100	99

The first column of the table gives the dates on which observations were made, the second column the hour of the day. The succeeding four columns give the different temperatures registered by the respective thermometers at the time of observation. There was a great difference in temperatures in different parts of the tray at the same time. The greatest difference at any one time was April 6 at 8:30 a. m. when thermometer one registered 105.8° F. and thermometer four registered 97° F. According to Alsop's results this great difference was reaching the proportion of danger if not fatality. At no time during the experiment did all the thermometers register the same. The least difference in the temperatures recorded by the different thermometers was on March 22 at 5:00 p. m. when thermometer one registered 104° F. and thermometer four registered 100° F. At no time did thermometer four register above 103° F. nor below 96° F. Egg number one upon which the bulb of this thermometer rested contained a dead embryo that was developed near to the point of hatching. As was stated previously, the incubation had lasted twenty-three days. The embryo was retarded in development, but was able to withstand

the effects of the abnormally low temperatures for a long period. Unfortunately no thermometer was near egg number five, which survived the twenty-three days of incubation but did not seem to be able to get out of the shell. Neither was there a thermometer near egg number eighteen, which survived seven days' incubation but was somewhat retarded in its development.

Thermometer number two ran below optimum most of the time. The embryo in the egg nearest it showed about fourteen days' development.

Since such a wide difference in temperatures of regions not far from one another, as shown in the table I, and also since there was such a great difference in the effect during incubation in eggs very near one another, it was thought best to repeat the experiment using more thermometers.

CHART NO. 2

Dead Considerably developed Egg one	Dead About six days' development Some decay Egg two	Dead Practically no development Egg three	Dead About twelve days' development Egg four	Alive and breathing Covered with down Egg five
Dead Only a little development Egg six	Dead Little development Egg seven	Dead Only slight development Egg eight	Dead About eight days' development Egg nine	Dead About seven days' development Egg ten
Dead Only a little development Egg eleven	Dead Little development Egg twelve	Dead Practically no development Egg thirteen	Dead Only a little development Egg fourteen	Dead Only a little development Egg fifteen
Dead About nine days' development Egg sixteen	Dead About eight days' development Egg seventeen	Dead With only little development Egg eighteen	Dead About five days' development Egg nineteen	Dead Only a little development Egg twenty

TABLE II

Date	Hour	Temperature							
		1	2	3	4	5	6	7	8
April 15	8:15	106	102	100	104	105.2	101.8	105	104.9
	11:40	106	101	100	101	104.9	102	102.2	101.5
	3:45	108	104	100	104	105	108.2	107.9	101
April 16	8:30	106	100	99	106	104.8	104.1	102	105.2
	11:40	106	102	101	104	105.4	103.8	105.2	100.8
	4:00	106	102	100	104.1	105.6	104	101	103.6
April 17	8:10	106	102	100	103.8	104	104	101	101.2
	11:40	108	102	100	104.5	105.2	102	101.5	102
	4:00	108	110	100	105	106.2	102.2	106	102
April 18	8:50	108	102	101	105.6	105.8	102.4	102	101
	11:20	106	102	100	105.8	105	102	104 2	101
	4:00	106	103	98	106.2	107.2	102.8	103	101.6
April 19	8:30	106	104	101	108	107	104	102.4	101.8
	11:30	106	106	101	106.2	106	104	102.2	100.9
	5:00	108	103	102	108.2	107 6	104.2	106	100.4
April 20	8:30	106	102	100	107	107	106	103	101.6
	11:40	106	102	100	106.5	107.5	105.2	102.2	102.4
	4:20	106	104	102	106.6	107.8	106	104	103.6
April 21	8:30	106	102	101	106	107	105.2	104	103
	11:30	106	102	102	105.4	106	104.2	103.8	103
	4:35	107	103	102	106.8	107.6	105.2	104.6	104.2
April 22	8:05	108	104	102	107.8	108.4	105.2	106	104.2
	11:45	110	105	102	107.6	105.4		105.2	108.2
	5:10	110	105	102	108	104.6		104.2	105.6
April 23	8:15	112	106	102	108.2	106		105.2	105
	11:50	109	106	103	109.1	106.2		106.4	105
	4:10	109	105	103	106	106.6		107.2	105.2
April 24	8:05	108	103	103	108	105.6		107	105.8
	11:40	108	106	104	110	107.2		108.2	105.8
	5:00	109	103	102	109.2	108		107.2	106.2
April 25	8:50	109	102	103	107.8	109.2		107.6	106.6
	11:25	109	104	103	108.5	107		106	105.8
	5:00	109	106	104	109.2	106		105.4	104.2
April 26	8:30	109	106	104	110	109		105	104.2
	1:50	108	107	104	108.6	110		105	104.2
	5:00	108.5	104	102	109.2	107		104	105
April 27	8:10	109	106	104	108	110		103.8	104.2
	11:45	109	106	104	107.6	108.8		104.6	104
	5:00	109	104	104	109.2	108		104.6	106
April 28	8:30	110	106	103	107	107.4		108.6	106.2
	11:00	110	104	103	103	110		108.8	106

The results of this experiment are shown in chart II and table II. In this experiment eight thermometers were used. Thermometers one, two and three were the thermometers used in the previous experiment, and the other thermometers were clinic thermometers suspended in the incubator with bulbs almost touching the eggs. The figures on the chart show the location of the bulbs of the respective thermometers. Thermometer number six was broken on the morning of the eighth day of the experiment. The experiment was continued for thirteen days, after which the eggs were opened.

Thermometer number one registered above the optimum temperature from the beginning of the expeiment. The chart shows that egg thirteen, which was under this thermometer, was fertile but the embryo had died with practically no development. Thermometer two registered near optimum temperature until the last part of the third day when it jumped to 110°. The chart shows that egg number twenty, which was immediately under this thermometer, was dead with only a little development. Thermometer number three registered below optimum until about the middle of the ninth day. The remainder of the time of the experiment it ran at nearly optimum. Only a few times did it go to 104° F. At the end of the experiment egg number one, which was beneath this thermometer, had a dead embryo in it, but it had developed considerably and had the appearance of having been dead only a short time. The low temperature had evidently retarded the development, and the embryo was unable to survive the effect of it. Thermometer four was between eggs number sixteen and seventeen. The temperature was above optimum for almost the entire experiment, but for the early part of the experiment only twice did the temperature rise to 108° F., which according to previous results, has been fatal in most cases. It will be noted, however, that it remained at this temperature for only a short time. The chart shows that egg sixteen had reached about nine days' development and egg seventeen had reached about eight days' development before the embryo died. It seems that the excessive temperature hastened the development, but at the end of the seventh day, or the beginning of the eighth day when the temperature remained for sometime around the danger point, the embryos were not able to survive. A superficial examination shows that both of these embryos were very abnormal. The extent of the abnormality has not been determined. Thermometer five, like thermometer one, registered high from the beginning with similar results. Thermometer six, except for a short time, at the end of the first day, registered near the optimum temperature, until the end of the fifth day. After that until the time it was broken on April 22nd, it registered above optimum. It was between eggs ten and fifteen. Egg ten reached about seven days' development before the embryo died, while egg fifteen had developed but little. It will be seen though, that egg fifteen was not far removed from thermometer two, which ran up to 110° F. on the third day of incubation. Accord-

ing to previous experiments this was almost sure to be fatal. Thermometer seven registered considerably above optimum temperatures during the early part of the experiment, and while later it registered near to optimum, yet eggs six and seven developed but little. They were evidently unable to withstand the high temperatures of the early period. While on the average thermometer eight registered above optimum, yet at only one time did it reach the point which has proved fatal in most cases. The development in egg number five, whch was under thermometer eight, continued longer than any other one of the experiment. The chart shows that the embryo was alive and breathing at the close of the experiment.

III. DISCUSSION

For centuries heat has been recognized as a chief factor in producing development in the eggs of the chick. This has been acknowledged in the manufacture of artificial incubators. One of the big factors in the success of artificial incubation is conceded to be the regulation and the distribution of heat. Dryden ('16) says that "artificial methods would be more generally used than they are were it not for the fact that there are problems in artificial incubation and brooding that are not encountered in natural incubation and brooding." He further shows that in the Oregon Experiment Station the incubator hatched 78.5 per cent of fertile eggs while the hen hatched 96.5 per cent fertile eggs, and that the incubator tested 22.7 per cent infertile eggs, while the hen tested 11.8 per cent infertile, furthermore, the incubator had 16.6 per cent dead in the shell, while the hen had 2.8 per cent dead in the shell. In the Ontario Experiment Station, incubators hatched 45.5 per cent eggs set, and hens hatched 58.5 per cent eggs set. He further states that the best results can be secured only when the temperature is kept steady in all parts of the egg tray, but he does not give any data as to the temperature in different parts of the egg tray. The foregoing experiments of the writer show that too much emphasis cannot be placed upon Dryden's statement, and furthermore, that in the two types of incubators used, there is a great difference in the temperature in different parts of the egg tray at the same time. The differences in the hatches under hens and in artificial incubators may be in part due to this factor. It is well known that the hen frequently moves her eggs about in the nest while incubating them. While this would not change the temperature in different parts of the nest, it would tend to equalize the temperature so far as the eggs are concerned.

The writer is inclined to believe that the difference in fertility as recorded for eggs incubated in an incubator and those incubated under the hen is not in reality a difference in fertility, but is due to early mortality. Since eggs are not candled out until the third day, many eggs could have started to develop and the embryos have died early, which would not be revealed as a result of candling. Stockard ('21) has shown that in the fish there are critical and passive moments in the development of the embryo. While exact

periods have not been so definitely shown in case of the development of the chick, yet there is evidence which indicates that some periods are more critical than others. Payne ('19) has shown that the rate of mortality during the period of incubation in the chick is not constant but may be represented by a bimodal curve, the sharply defined peaks of which are on the fourth day and the nineteenth day of incubation. Payne determined these periods by candling, and no doubt that some of the eggs judged infertile were not infertile, but had been killed in the early periods of incubation. Nevertheless, Payne's experiment shows that there are at least two very critical periods in incubation.

Dareste ('91) concluded that abnormalities produced in chick embryos were due to arrest of development. He, also, maintained that heat is a large factor in this arrest of development.

Wood ('06) says that experienced incubator operators feel well satisfied if they find that their entire season's work gives them an average of fifty chicks hatched for each hundred eggs set. With the price at which eggs have been selling during the last few years, this average makes artificial incubation rather expensive. The experiments of Eycleshymer ('07) and Alsop ('19) have shown that there is an optimum temperature at which development in the chick takes place most normally, and a slight variation in either direction from this optimum produces a high percentage of mortality. The above experiments of the writer show that these variations from the optimum temperature may be present in a single tray of the incubators in common use. This fact may account for the low percentage of hatch although the observations of the thermometer shows almost a constant temperature since usually only one thermometer is used and at most, seldom more than two.

IV. CONCLUSIONS

1. A small variation during incubation from the optimum of 103° F. produces a high percentage of abnormal embryos.
2. If this variation is five or more degrees above or below the optimum, a great mortality results.
3. In our common incubators the optimum temperature may be almost constant at one place in the incubator, while at the same time other parts of the tray may be above and still others below the optimum.
4. Chick embryos can survive the low temperatures longer than the high temperatures.

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The Tray System for Insect Collections

Paper 26 of the 1926 Meeting at Winfield
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After considerable thought and investigation, the Department of Entomology of the Kansas Agricultural College has adopted the tray system for the permanent insect collection.* This brief account, embodying the advantages of this system, is given in the hope that it might be of value to workers in other institutions in the state.

History of the Tray System

The tray idea probably originated with geologists who, for many years, have used small pasteboard trays or boxes for minerals or rock fragments. The use of the pasteboard trays for insects probably was suggested by the old Comstock system, upon which it is an improvement. The only published account of the system is by Aldrich (1919)**. The trays were first used for an insect collection by the United States National Museum, where the details and plans were worked out in 1910 and 1911 by Messrs. Rohwer, Crawford and Viereck. Mr. Rohwer stated (in littera that "Mr. Crawford devoted a great deal of his time to planning out satisfactory sizes and I may say that we tried a number of different sizes, not only in the width of the trays, but also in the length, and after trying out all of them we believe that the system we accepted is the most practicable. It was first put in use in the Hymenoptera, with the smaller at that, but later we expanded it to all of the sections of the Hymenoptera and gradually workers in other groups took it up, until now all of us, with the exception of groups of the Macrolepidoptera and the Odonata, think that it is by far the most satisfactory way of housing the collection."

This system is now used by the University of Minnesota, Iowa State College (in both cases being introduced by Dr. H. H. Knight), at Mississippi State College, at Cornell University for the Hymenoptera, and the American Museum of Natural History for certain groups. Several other institutions have been considering seriously its adoption and probably have done so by this time.

Explanation of the Tray System

This system makes use of small, white pasteboard trays of uniform

*We are greatly indebted to Mr. S. A. Rohwer, who has charge of the work on Taxonomy of the Bureau of Entomology, stationed at the National Museum, and other members of the Bureau for advice and suggestions, to the National Museum, and to Dr. Aldrich of the Museum, for samples of trays and plans for drawers and cases. Further acknowledgment is made to Dr. H. H. Knight, Dr. W. T. Forbes, Dr. Foster H. Benjamin, and Prof. R. W. Harned, for suggestions and expressions of opinion.

*.Aldrich, J. M. The Division of Insects in the U. S. National Museum. Annual Report Smithsonian Inst. for 1919, 1921. 367-379. 15 pl.

width, but of several different lengths, in which sheet cork is glued. The sizes used by the United States National Museum and adopted by us are as follows:

Size 1—1¼x4x1⅝ inches; requires a cork strip 1x3 13-16 inches
Size 2— 2x4x1⅝ inches; requires a cork strip 1 13-16x3 13-16 in.
Size 3— 4x4x1⅝ inches; requires a cork strip 3 13-16x3 13-16 in.
Size 4—7¾x4x1⅝ inches; requires a cork strip 7 5-6x3 13-16 in.

The U. S. National Museum has recently introduced a half column width tray of the smallest size for species represented by only one or a very few specimens. This improvement makes it possible to fit two tiers of trays into the ordinary column, and an appreciable saving of space is attained.

The trays are of good grade of heavy pasteboard with the outsides covered with white glazed paper. This is glued on the bottom and on the inside of the tray, the strip overlapping in each case being about one-half inch. The trays are manufactured by machine and are of uniform measurements.

These trays are kept in a drawer similar to the old Comstock case. The U. S. National Museum drawers measure, on the outside, 18x18x2¼ inches. The glass lid is tight fitting, with a tongue and groove jointing on the two sides and the back edge, but with a beveled edge in front. The groove in which the tongue on the lid fits is open to the bottom of the box. This groove around the box may be filled with flake napthalene or paradichlorobenzene crystals to keep out museum pests.

It is planned to keep these trays in a steel fire-proof cabinet, but until these can be purchased, they will be kept in an oak cabinet holding 100 drawers in four tiers of 25 each.

Advantages of the Tray System

1. It is well adapted to a growing collection. When the specimens are correctly determined, each species is pinned in an appropriate sized tray which is then placed in the drawers in the proper systematic position. When other species are added, the trays may be shifted ahead with a great saving in time over the Schmitt box method and without handling the specimens.

2. It minimizes the handling of specimens and thereby removes the greatest possibility of breakage. Specimens once placed in the trays, if correctly determined, need not be removed. When it is desired to examine some determined material to identify by comparison, the entire tray is removed and the specimens examined under a binocular. The box affords a coonvenient way of handling the specimens, the entire determined series with the usual variations are before one, and there is very little probability that the determined specimens will be put back under another determination heading. It is not unusual to find isolated specimens in the wrong group in the Schmitt boxes. Some taxonomists now put a determination label on every specimen to counteract this situation.

3. It makes possible the placing of galls, leaf mines or typical injury with the adults causing them.

4. It makes possible the keeping together of biological series, rearings from a single gall, collections from a certain host, or in a certain restricted habitat as is done in the United States National Museum.

5. Broken parts can be readily associated with the proper species, or with the proper specimen, for they will be found in the tray. Slides of parts of specimens or in toto mounts can be placed in the trays with the particular species or specimens. Special wood slots are glued in the ends of the trays to hold the slides in place.

6. The danger of damage from museum pests is slightly reduced by the many partitions in the drawers and by the increased amount of napthalene or paradichlorobenzene which, by the way, is hidden from view and does not, therefore, detract from the appearance of the box. The drawers do not need replenishing with the repellent as often as with the Schmitt box or Comstock box.

7. The danger of breakage from loose moth balls is eliminated. It is not uncommon for the moth balls in which heated pins have been imbedded to become loose or drop off of the head of the pins when evaporated to half their size. In either case, they may roll around in the box, with disastrous results. Where the naphthalene flakes are kept in glass cups, as is done at the Museum of Comparative Zoology, this danger is eliminated, but then the boxes must always be handled right side up.

8. It provides a big advantage over the Schmitt box for identification by comparison and reduces damage from opening and closing the lid. The name of the genera and in some cases some or all of the species are typewritten on a card which is held by a label bracket on the right (or left side if desired) of the front of the box. The glass top makes it possible to get the desired information many times without opening the lid. The glass is very close to the specimens, there being only one-eighth to one-fourth inch clearance above the heads of the pins. In the Schmitt box, the lid must alway be raised and the inrush of air often damages the delicate wings of moths, neuropteroids, termites, May flies and similar forms. This danger is reduced with the large glass-topped drawer used in the tray system.

Disadvantages of the Tray System

No really important disadvantages have developed, but the following, however, have been suggested.

1. At the prices paid by some institutions, the tray system is the most expensive yet devised. But, according to the prices paid by the Kansas State Agricultural College, the cost is approximately the same as with the Schmitt box system which has been in use there. Without going into details of costs, it probably will be sufficient to point out that Schmitt boxes now cost \$2.75 each. The drawers used for the trays were made by the college Building and Repair Dpeartment for \$2.78 each for one order of 50, and \$3.15 each for a later order of 50 boxes. The pasteboard trays cost \$24.00 per

M. for sizes 1 and 2; $26.00 per M. for size 3, and $30.00 for size 4. The cork for the trays cost forty cents a sheet 11x15 inches. These sheets were sawed to the proper sizes with a small circular saw, after which they were glued in the trays with LePage's glue. Since there is a tendency for the cork to bulge, even when weighted down while drying, probably it is a better plan to pin the sheet cork in the bottom of the trays, which can be done with four ordinary pins pushed in horizontally from the outside of the trays, so as to enter the cork. The tray system, at present prices, is a little more expensive than the Comstock box system, but the latter has most of the disadvantages which the Schmitt box has.

2. This system does not provide for ready examination of the under part of the body or wings of pinned insects. The only boxes, so far as the writer knows, which allows for this are the glass-bottomed Comstock boxes used by Dr. W. T. M. Forbes at Cornell University. Strips of soft wood are tacked or glued at regular intervals in the bottom and the Lepidoptera are then pinned to the strips.

3. Insects in the drawers would be damaged if the drawers were inverted. Since the space between the glass and the pin-head is only one-fourth inch, the trays will not become disarranged if the drawer is full. Furthermore, there is no occassion for inverting the boxes, but it may occur by accident. The old Comstock system, using flat pieces of soft wood had this very serious objection which is largely responsible for its disuse.

4. It requires somewhat more space with the trays to care for the larger specimens. This is true and to offset this disadvantage, some institutions glue a sheet of cork in the drawer and pin large specimens in it, omitting the trays.

This system has the recommendation of all the taxonomists which were consulted, or about a dozen of the leading ones. Some institutions would adopt it if it were not for the fact that they already have so much money invested in other boxes. Other institutions, or those in which their insect collections are not now in proper form, should investigate this system before continuing with other less efficient and more cumbersome systems, or before spending further sums for continuing them.

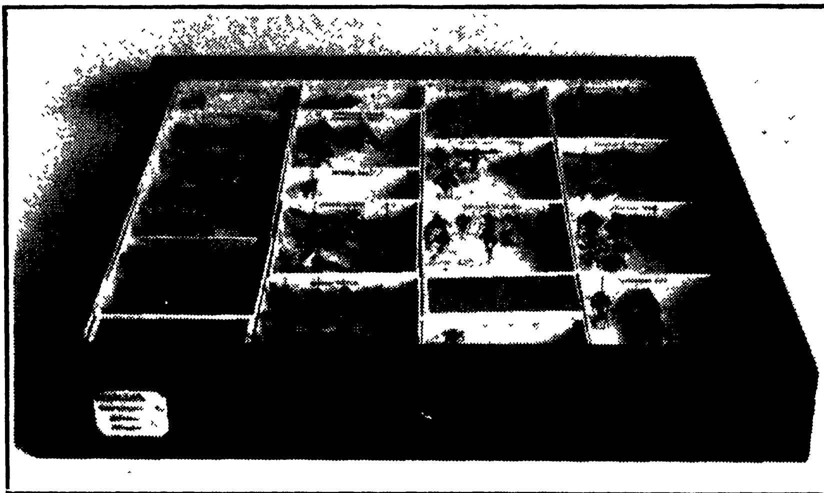

Figure 1 Note that name label is glued to front end of tray The colored slips placed at right fore margin of each tray designate the Zoogeographical Region from which the specimens came To designate these regions the following colors were used Palaearctic, green, Oriental, yellow, Aethiopian, blue, Australian, black, Neotropical, pink or reddish, Nearctic, no color applied to tray This sample illustrates all sizes of trays except the entire column tray which is usually used for "blocking" purposes only.

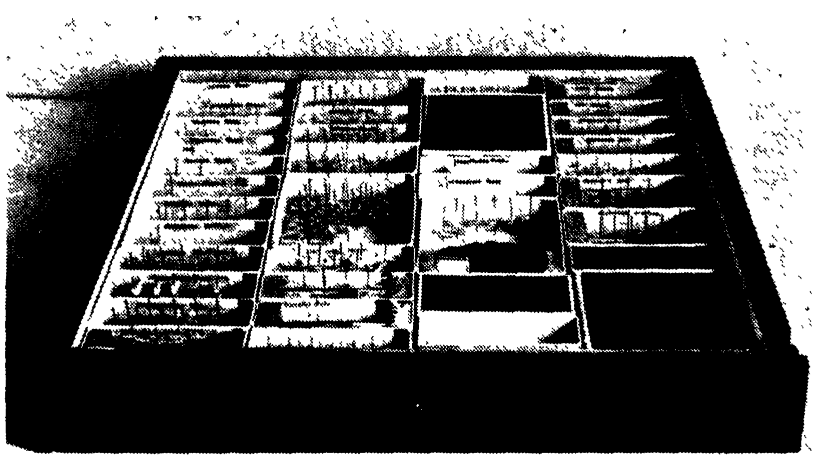

Figure 2· Note how slides are fitted into especially prepared trays in which may also be pinned the adults from which the parts mounted on slides were removed.
Note also the naphthalene chamber which surrounds the drawer.
(Photographs loaned by the U. S National Museum through the courtesy of Mr. S A Rohwer.)

A Soil Study in Scott County, Kansas*

Paper 27 of the 1925 Meeting at Manhattan
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The geological formation of Scott county is Tertiary (1), (2), a period in which there occurred a heterogeneous deposit of sand, gravel, clay, and soil above the previous Cretaceous formation. The loose unconsolidated materials comprising the Terteriary formations are derived from Rocky Mountain wash.

The land under study covered four townships southwest of Scott City. In general it may be described as an area rather flat in topography with a gradual slope toward the east and having a soil that is quite uniform in texture and color. A dark brown silt loam with a porous silty clay loam sub-soil light grey or yellow in color is typical of the region. The soil lying west and south of the town of Shallow Water may probably be classified as belonging to the Colby Soil series and the soil north and west as containing areas

*Contribution No 157 Agronomy Department and No 110 Chemistry Department, Kansas Agricultural Experiment Station

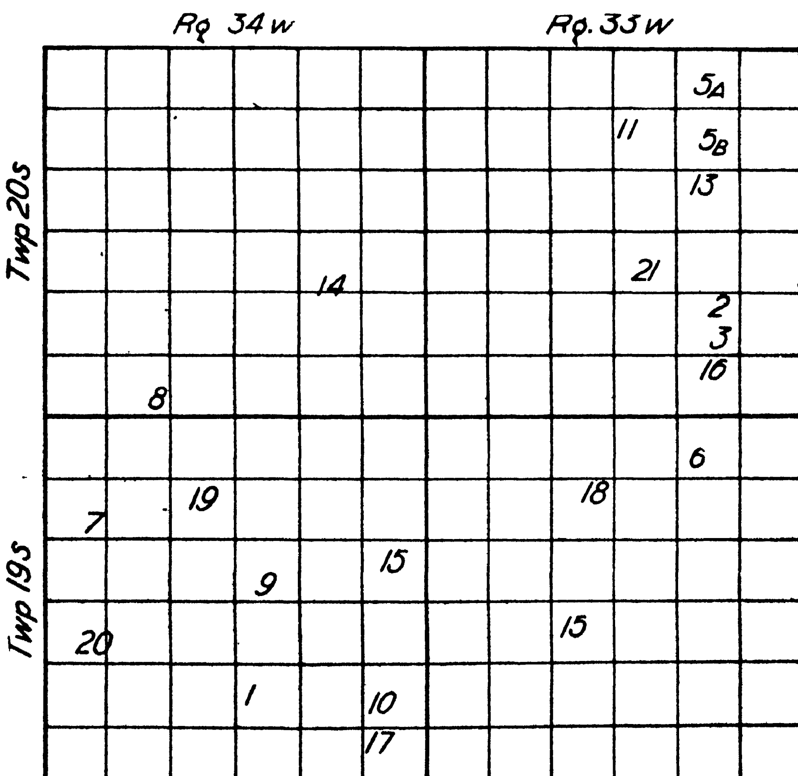

Fig. 1—Diagram showing location of soil samples

of Scott clay loam and Scott Silt loam series. Where gravel is in evidence in river channels it is composed of granite, syanite porphyry, andesite, rhyolite, basalt, and pure quartz.

Each soil sample taken for analysis represents a composite of about twelve seven inch borings, taken at the points indicated in figure 1. The subsoil samples were taken with a steel tube to a depth of six feet.

TABLE I. Average Soil Analyses of the Samples by Townships.

	No.	Nitrogen		Phosph.		Calcium		Inorgan. Carbon		Organ. Carbon		Total Carbon	
	Sam	sur.	sub.	sur.	sub.	sur.	sub.	sur.	sb.	sur.	sb.	sur.	sub
R 34W T 19S	2	.141		.059		.362		neg.		1.49		.149	
R 34W T 20S	8 - 1	.124	.032	.057	.056	.377	5.34	neg.	1.53	1.44	.36	.120	1.89
R 33W T 19S	4 - 3	.140	.051	.067	.061	.747	2.56	pos.	0.58	1.46	.51	.150	1.22
R 33W T 20S	3	.128		.058		.433		pos.		1.41			1.41

Table 1 presents the average soil analyses of the samples, by townships. Subsoil samples represent the sixth foot. The soils are low in percentage of nitrogen compared with the average amount of nitrogen in productive soils in humid regions, which is 0.20 percent for the surface seven inches. On the basis of 2,000,000 pounds as the acre weight of the surface seven inches of soil, this amounts to 4,000 pounds of nitrogen per acre.

The Scott County soils with 0.124 to 0.14 percent nitrogen would contain approximately 2,520 pounds of nitrogen per acre. According to Swanson (3), cultivated soils in eastern Kansas contain 3,7000 pounds of nitrogen per acre in Riley County; 2,960 pounds in Russell County; 2,800 pounds in Butler County; and 2,440 pounds in Allen county. Sod lands in these eastern counties contains over 4,000 pounds of nitrogen per acre. The amount of nitrogen present in the native sod lands of Scott County is no doubt sufficient for crops grown under conditions of limited rainfall. Whether the soils would respond to applications of nitrogen when under irrigation depends upon the question of fixation of free nitrogen by western soils.

Headden (4) found that Colorado soils showed an increase in nitrogen content where the soils were maintained in a moist condition by irrigation, this increase being due to nitrogen fixing organisms. Gainey (5) of the Kansas Agricultural Experiment Station has shown that Azotobacter are active in fixing nitrogen when the soils are neutral or slightly alkaline in reaction and are well supplied with organic matter. It is possible that western Kansas soils may contain more nitrogen through nitrogen fixing bacteria when irrigation brings about optimum moisture conditions.

Buffalo grass does not afford much herbage to be returned to the soil and thus develop an accumulation of organic matter. Soils with this character of native vegetation are necessarily low in organic matter.

Organic matter is considered to be composed of 50 percent carbon. The Scott County soils contain 1.49 to 1.41 percent organic carbon. With 1.49 percent, the soils would contain 59,600 pounds of organic matter per acre; with 1.41 percent 56,400 pounds per acre. Native buffalo sod in Russell county in the west central zone of the state was reported by Swanson (3) to contain 98,400 pounds of organic matter per acre; and native pasture in Butler County in the eastern zone, 106,400 pounds. However, in Reno County, native pasture contains but 74,800 pounds of organic matter. When compared with these more eastern counties, the Scott County soils are low in organic matter.

Regarding the water relations of soils, their absorption and retentive capacities for water are greatly augmented by organic matter in its various states of decomposition. A system of irrigation in this western region should include the incorporation of organic matter in the soil. This practice would not only improve the moisture conditions of the soil, but would maintain a soil structure that would safeguard any tendency toward blowing; furthermore, additions of organic matter would supply carbohydrate material needed to furnish energy for nitrogen fixing organisms.

The soils under study are remarkably high in phosphorus. The amount of phosphorus in the average productive soil has been estimated as 0.04 percent. These soils contain approximately 0.06 percent in the surface soil and the same amount in the subsoil down to the depth sampled which was six feet.

There is an abundant supply of calcium particularly in the subsoil. The surface soils are either neutral or alkaline in reaction. No determinations were made of the amount of potassium because earlier analyses of soils in Finney County, adjoining, had shown an abundant supply of potassium. Similar supplies of potassium had also been found in other western counties.

The soils were tested for alkali salts and were found negative except for two sixth foot samples which gave indication of a tract of sulphates.

Water samples were taken from four domestic wells which varied in depth from 27 to 46 feet One of the wells located near the town of Shallow Water contained 1100 parts per million of soluble salts. This wéll was 27 feet in depth. The amount of salts in the other three wells sampled were negligible. The water analyses are given in Table II.

TABLE II. WATER SAMPLES

1. 337 P. P. M. Total solids
2. 197 P. P. M. Total solids
3. 1119 P. P. M. Total solids
   774 P. P. M. Sodium sulphate
   345 P. P. M. Calcium carbonate
   30 P. P. M. Calcium sulphate
   Practically no chlorides
4. 226 P. P. M. Total solids

The well containing 1100 parts per million of total solids in the water was across the road from an irrigation well. The salts in solution were 744 parts per million sodium sulphate. This is a considerable amount of sodium sulphate for water that is used for either domestic or irrigation purposes.

In consideration of the question of the use of this water for irrigation purposes, references may be made to the analyses of some characterstic alkaline river waters in Kansas and Colorado. The Cache la Poudre, two miles above Greeley, Colorado, contains 1571 parts per million total solids, 60 percent being sulphates. The Platte River below Cache la Poudre, Colorado, contains 1,011 parts per million total solids, of which 55 percent are sulphates. The Arkansas at Rocky Ford, Colorado, contains 2,134 parts per million total parts of which 60.7 percent are sulphates. These streams are the source of irrigation water for districts noted for their productive agriculture. The well water in question contains 1,100 parts per million total solids of which 744 parts per million are sulphates. From the available experiments reviewed by Harris

Hilgard (7) states that although 685 parts per million of the common alkali salts should be the limit under most conditions, the nature of the salts modify the limits considerably. Where salts are of the sodium sulphate type, Forbes (8) states that with good drainage 1,000 parts per million of salts in irrigation is an objectionable but permissible degree of salinity for Arizona.

Salt grass is the native sod near the domestic well, the water of which has been discussed. Although salt grass (Distichlis spicata) occurs on soils containing from 30,000 to 50,000 part per million of salts, yet it does well in soils containing practically no salt. It does not show preference for the type of alkali nor for the concentration.

"Buffalo wallows" characterize the region in which the soil samples were taken and the native vegetation is buffalo grass. These wallows or sinks may vary in diameter from severel feet to about three hundred feet. Samples were taken to a depth of seven inches on about 25 sink areas and composited for chemical analyses. These soils contained sodium sulphate which probably accounts for their deflocculated physical condition. The surface is low in nitrogen, otherwise its analysis is similar to the other soils. These sink areas have a normal porous subsoil beneath the surface ten inches of slick gumbo soil.

(6) the toxic limits of sodium sulphate in soils lie between 2,500 and 5,000 parts per million.

The buffalo wallows or sink areas have been originally natural depressions caused by unequal settling of the surface mantle. Buffalos probably did wallow in the soft, moist soil of these depressions and carried away much soil as mud, plastered to their backs. When the soil was dry these areas probably furnished a place for the herds to bunch and throw dust in fighting insects.

TABLE III. SOIL ANALYSES. SCOTT COUNTY. (Elements expressed in percentages.)

	Nitrogen		Phosphorus		Calcium		Inorganic Carbon		Organic Carbon		Total Carbon	
	Surf.	Subs.	Surf.	Subs.	Surf.	Subs.	Surf.	Subs.	Surf.	Subs.	Surf.	Sub
Range 33W. Twp. 19 S.												
Samples 13	0.150		.071		1.590		.33		1.48		1.81	
Sod 5A—3rd ft.		0.043		.054		2.520		.61		.39		1.00
Sod 5B—6th ft.		0.065		.070		2.18		.48		.75		1.23
11	0.145		.072		.400		Neg.		1.59		1.59	
21	0.138		.061		.384		Neg.		1.51		1.51	
Sink area 2—18"—7'		0.035		.060		4.26		1.11		.33		1.44
3	0.126		.063		.615		.04		1.08		1.12	
Normal 16—18"—7'		0.046		.063		2.980		.65		.40		1.05
Twp. 20 S.—6 part sod	0.133		.062		.384		Neg.		1.53		1.53	
Sandy soil—18	0.111		.054		.460		Pos.		1.20		1.20	
Sod—15	0.139		.060		.456		Pos.		1.50		1.50	
Range 34 W. Twp. 19 S												
Samples 14 sod	0.138		.061		.36		Neg.		1.52		1.52	
Sod 8	.144		.057		.344		Neg.		1.47		1.47	
Range 34 W Twp 20 S. 12	.124		.060		.36		Neg.		1.29		1.29	
Sod 10—6th ft.		.032		.56		5.34		1.53		.36		1.89
Sod 1	.132		.052		364		Pos.		1.22		1.22	
Sod 4	.130		.058		.348		Neg.		1.42		1.42	
9	.131		.056		.405		Neg.		1.24		1.24	
19 sandy soil	.115		.055		.392		Pos.		1.23		1.23	
7 sod	.106		.056		.296		Neg.		1.22		1.22	
20 sod	.130		.059		.344		Neg.		1.51		1.51	
17 sod	.124		.063		.512		Pos.		1.33		1.33	
Scmposite of Sink areas	.089		.071		.663		.04		.96		1.00	

The depressions naturally formed and deepened by buffaloes in the above manner allowed the accumulation of salts as water collected from surface drainage evaporated. Sodium sulphate as one of the accumulated salts increased the puddled condition of the soil by its deflocculating action.

The puddled condition of the buffalo wallows can probably be remedied by the use of lime and the incorporation of organic matter. By changing the soil structure the puddled condition well be corrected and natural sub-drainage restored.

Table III presents the complete data of the soil analyses and permits a study of the unifomrity of the soil within the area of the four townships.

Except for the samples from the sandy loam soils, the variation in nitrogen is from 0.126 to 0.15 percent. Phosphorus varies from 0.057 to 0.07 percent.

The few samples taken from ridges that were composed of a sandy rather than of a silt loam contained less nitrogen and phosphorus than the silt loam which is the dominant soil class.

The chemical analyses of the soil and water, together with observation during a period of several years lead to the conclusion that the soils of this region are very productive; the moisture is the limiting factor in crop production; and that the feasibility of pumping water from wells for irrigation is only a question of pumping costs compared with the value of the crops grown.

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A New Kansas Meteorite

Paper 38 of the 1924 Meeting at McPherson

H. H NININGER
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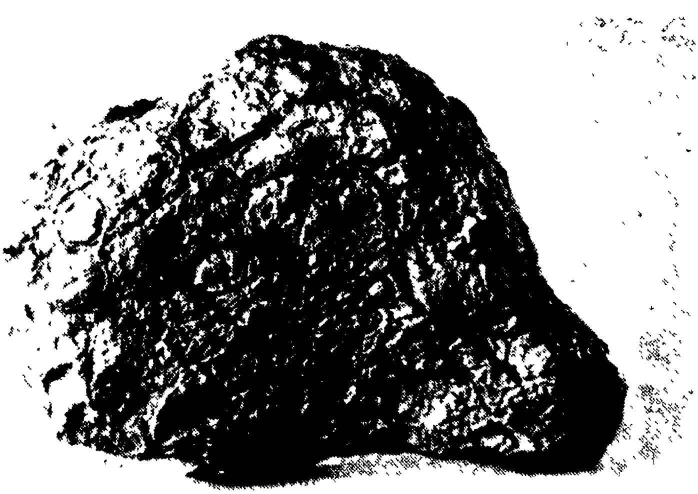
An undescribed meteorite for which I am proposing the name Coldwater Meteorite came to my attention on December 9, 1923, while in the village of Coldwater, Kansas, collecting information regarding the meteoric fall of November 9, 1923. Mr. A. M. Brown showed me an oddly shaped mass of stone resembling limonite. It was almost black, about eleven inches in its largest dimension, and shaped somewhat like a ham of pork. The surface was strikingly fissured, checked, and blistered, giving it the appearance of having been roasted in an oven. In fact I have several times been impressed by the resemblance which it bore to a volcanic bomb. The appearance is well shown by the accompanying photograph.

The specimen came into my possession at the time and was brought to McPherson College. It was found to weigh 41 pounds, and the specific gravity was roughly determined to be 3.9. After photographing it the mass was sent to the United States National Museum for cutting and analysis. Upon cutting the mass showed no trace of metal with the exception of some almost microscopic particles which were thought by Dr. Merrill to be schreibersite, but which are not so reported in the final analysis. In appearance the mass resembles a concretion of limonite, being practically the same throughout. The



chemical analysis was made by Booth, Barrett, and Blair of Philadelphia, and was submitted to the writer by Dr. Geo. P. Merrill. It follows:

SiO_2	2.910%
Al_2O_3	1.610%
Fe_2O_3	81.595%
P_2O_5	0.621%
CuO	0.038%
NiO	1.999%
CoO	0.113%
MgO	0.331%
SO_3	0.219%
	89.436%
Residue in 1-1 HCl	3 361%
Water (red heat)	7.205%
	100.002%

The residue is white and containns no schreibersite nor other alloy. Its composition is:

SiO_2	78.56%
Ferric oxide and alumina	
R_2O_3	13.74%
Na_2O	3.15%
K_2O	4.55%

The circumstances surrounding the finding of this body were given me by Mr. Brown as follows: "I found the specimen 4 1-4 miles west and 1 3-4 miles north of the depot at Coldwater, Kansas. (These distances might vary a few rods.) It was located in the N. E. quarter, Sec. 5, Range 19, Twp. 32; in the S. E. quarter of the N. W. forty of said quarter. It was found sometime during the middle of May, 1918."

Notes on Kansas Meteorites

METORIC FALL OF DECEMBER 17, 1923

Paper 39 of the 1924 Meeting at McPherson

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McPherson College, McPherson, Kansas

On December 17, 1923, at approximately 9:00 p. m. another meteor was seen by several students of McPherson College who reported to me the next day. A notice through the press brought information which indicated that it was more than a shooting star. The general location of its disappearance was determined to be in the vicinity of Whitewater, Kansas. Up to this time I was not convinced that the body had been of important size. Nevertheless, reports of violent shaking of buildings in several places kept reaching me and

I asked Professor B. E. Ebel of our institution to gather further information regarding the matter while on a trip to Hillsboro. He reported that Mrs. P. C. Hiebert was coming upon the front porch of her residence to enter the house, which faced the east, when her attention was attracted to a very extraordinary light. Looking to the southeast she witnessed a large ball of fire disappear behind the east end of the house just south of her. Her husband. Professor Heibert, who was in the house, saw the light but not the source of it. After what seemed two minutes a sound as of thunder was heard and the windows and doors, as well as the dishes in the cupboard, rattled quite violently.

Prof. Ebel also learned that a young man named Schellenberg was walking along the street of the same city when he saw the remarkable "fireball" and after walking about two blocks was just in front of the residence of the banker, Mr. P. F. Friesen, when he heard the sound. In a few moments Mr. Friesen came and opened his front door and inquired of Mr. Schellenberg whether he knew who had been shaking his door. Numerous other persons of the same city saw the phenomenon, only two of whom have been consulted by the writer. These were Misses Marietta Byerly and Mamie King, teachers in the high school. Their reports agree substantially with what has already been given. All indicate that a body passed to the east of Hillsboro, traveling in a southward direction, and that it disappeared about 10 to 15 degrees above the horizon. Some thought it exploded, while others thought that it merely "went out".

Four persons in Marion who had seen the body descend were interviewed by the writer. These all agree that the meteor passed to the west of that city and was traveling in a southward direction. Those whose views were unobstructed by trees saw the light go out a little west of south and near the horizon. To some it seemed to explode, to others it merely "went out". A rumbling sound similar to loud thunder was heard but without the sudden clap of thunder near by. Houses were caused to vibrate so that doors and windows rattled more or less violently. Mr. J. B. Stuart, high school coach in Newton, was walking along the street in company with his wife when the meteorite fell. Having studied astronomy in college, he made a special effort to determine as many facts as possible regarding the phenomenon. According to his observation (made without instruments) the meteorite first attracted his attention when about 15° north of east and at an altitude of 55° to 60°. It traveled at an angle of about 30° with the horizontal and exploded 25° south of east and at an altitude of 25°. When they had walked about a block, which he estimates to have required from one and one half to two minutes, a rumbling sound was heard which continued for some seconds, increasing to almost a roar. No sharp sound was heard, but a sound such as is produced by blasting a few miles away. After the explosion, which produced a number of sparks, Mr. Stuart was able to discern only one piece descending as a red spark. This piece fell very much more abruptly downward than the former course of the

meteorite. The velocity at which it fell would indicate that it was a body of some weight. Later determinations prove that the distance of the explosion from Mr. Stuart was about 17 1-2 miles.

From El Dorado, to the southeast of the point of its explosion, four witnesses have been interviewed on the very spots from which their observations were made, and the reports coincide almost exactly with that of Stuart in Newton, except that they of course saw the explosion to the northwest. In other words, it was about midway between them, which would throw its location just northeast of Whitewater. Only one person of the four in El Dorado saw the piece descend after the explosion. His testimony agrees very well indeed with what was seen from Newton. No one of the four had recorded in degrees the altitude of its disappearance, but by having them point out to me by means of objects such as stars, or by branches of trees through which they were looking at the time they saw the body fall. I was able to discover a very good agreement among them as to the altitude at which the light disappeared. Three of them placed its altitude at from 18° to 20°, while a fourth rather uncertainly located it at an altitude of 35°. The distance from El Dorado to a point of explosion, as later determined by nearby observers, was 17 miles. So an average of the El Dorado reports agrees very well with that of Mr. Stuart in placing the altitude of its disappearance at 20° to 25° degrees for observers at a distance of 17 miles. In the matter of sound the reports from El Dorado indicate about the same degree of disturbance as was reported from Newton.

In Wichita, 28 miles S.SW. from the point of disappearance of the meteor, several observers were interviewed. Here the work of Dr. Carreau, optician, was of great value, as was that of Mrs. O. S. Rich. Both of these people possess clear minds and were able to give rather definite information. In fact, Dr. Carreau, by using his observations and those of Mrs. Rich, who was only 13 miles away, directly south of him, was able, working independently of the writer, to designate a point within a few miles of where the body actually disappeared. The pheromenon was seen by many Wichitans, all of whom agree as to its general location.

The next important step was a trip to Whitewater. Here through the co-operation of Mr. Davis, the local editor, we were put in touch with Mr. and Mrs. Nellin, both of whom chanced to be on the street in different parts of the village, and were able to give independent reports which agreed substantially that the light disappeared at an altitude of about 60° and directly northeast. Mr. E. C. Lewis, who was out in his yard at the time, 5 miles south and 2 1-2 miles east of Whitewater, saw it due north of him, and two members of the Jake Harter family, living three miles north and five east of Whitewater, who were in the yard, within a few feet of the northeast corner of their house, saw the light disappear at an altitude of 65° and slightly north of west. Three of these parties report violent detonations, and many people in the community saw the light and heard the thunder out of a clear sky, but failed to locate the source of the light or to

connect the sound with it. That none of the people who were nearest to the location of the fall saw anything descend after the light disappeared may be explained by the fact that everything was inky dark following the intense light. And all report that having had no previous experience with such phenomena it never occurred to them to look for anything of the kind.

According to the angles at which the body was seen from Newton and Eldorado, points about equi-distant on either side of where it disappeared, the altitude must have been about six or seven miles at the time of the explosion. According to observers in McPherson and Newton the meteorite traveled at an angle of approximately 30° with the horizontal. If this course were kept up until it struck the earth it should have traveled from ten to eleven miles farther south. But from the testimony of Mr. Stuart of Newton and of Mr. Peffley of El Dorado, the only persons who reported seeing a body fall after the light had disappeared, it should have come to earth from four to five miles south of the point at which the explosion occurred. This would place its location in the central part of Milton Township, just northwest of Brainard.

That the course of the meteorite was approximately due south is shown by the fact that it was seen to fall straight downward directly north of Ponca City, by two men of that city, and from the observations in Hillsboro and Marion, which indicate that it passed about midway between those two cities.

My conclusions are that on the night of December 17, at about 9:00 p. m., a meteorite of considerable size fell in Milton Township of Butler County, Kansas. It traveled directly south and descended at an angle of 30° with the horizontal, and exploded when about six or seven miles above the earth, flying into several pieces, one of which was of sufficient size to be plainly seen from a distance of 17 miles when giving off only a glowing red light, and of sufficient density to descend at a rapid rate of speed, and was finally lost sight of in the darkness at an altitude of something like two or three miles. Other pieces may have been equally large or larger, but if so they they did not glow so as to render them visible at this distance. Since the body exploded at a comparatively low altitude the fragments are probably not deeply buried and may come to light in the process of tilling the land, most of which in this locality is in a state of cultivation.

Another Kansas Meteorite

Paper 28 of the 1925 Meeting at Manhattan

H. H NININGER

McPherson College, McPherson, Kansas

On November 9, 1923, at 8:57 p. m., while standing with Professor E. L. Craik on East Euclid Street in McPherson, Kansas, the writer was privileged to witness the descension of a meteor which in bright-

ness surpassed any that I had seen before, with the probable exception of one which occurred some twenty years ago. It seemed from my position to be coming almost straight down on a line about thirty degrees south of west. The fact that it was descending in such a plane led me to think that it was worth while to try to locate the place of landing. Accordingly, I immediately marked the spot in which I stood and noted carefully the point at which the object disappeared behind a pine tree some nine rods away. A notice was sent to the press for others who saw the meteor to report as to the direction of its disappearance, its apparent course, its altitude, and the location of the observer. A few days later, assisted by Professor Chas. Morris, operating a transit, we were able to determine with a fair degree of accuracy the direction in which the meteor was seen to disappear; and a line drawn on the map in harmony with our findings passed through McPherson and Greensburg, Kansas. Later reports and calculations shifted this line so that it lay about ten miles farther south and parallel to the first location.

In a few days replies began coming in from those who saw the phenomenon establishing the fact that it was seen from points largely throughout the state of Kansas, parts of Oklahoma, and the northeast corner of New Mexico. It is probable that other would have reported from a greater distance had I used the sheets of wider circulation for my notice, instead of only Wichita papers.

Through the mail and through personal interviews reports were obtained from almost a hundred witnesses to this phenomenon, a few of which proved to be sufficiently definite to be of value in determining the location of the fall. By plotting on the map lines representing the more promising reports, a remarkable agreement was discovered in the fact that most of the lines intersected within a ten-mile circle adjoining Greensburg on the east. A few, however, from the western part of the state seemed out of harmony, and indicated points considerably farther west. This was disconcerting, since those agreeing on the Greensburg location were quite numerous, distributed widely on three sides of this point. However, those witnesses were in most cases 100 to 150 miles from the point of intersection and therefore the explanation might lie in the fact that Greensburg lay directly under the point at which a body traveling at the altitude of this meteorite would pass behind the horizon for observers at the distances named above. The variations in distance were not great with the exception of one, and this was from Herington, Kansas, which is almost exactly in the plane of descent of the body and would therefore not show any difference in the direction of the point at which the meteor disappeared. All of the other observers ranged in distance between 100 and 125 miles. One fact, however, stood in the way of drawing the conclusion that these many intersecting lines merely marked the point at which the meteor passed behind the horizon; and that was that several of those who saw it from this distance, and whose observations were among those which seemed to reflect

more than average intelligence, insisted that they saw the body burst into several pieces just before reaching the horizon.

The writer had been engaged to lecture before the Kiowa County Teachers Association on December 8 and determined to make further inquiry into the matter at this time. Accordingly, on December 7 an announcement was made before the Haviland High School, twelve miles north of Greensburg, and from several witnesses it was easily determined that the meteor had passed slightly south of that village and toward the southwest, where it disappeared before reaching the horizon. Other witnesses were found in Greensburg and in Belvedere and Protection to the south, to finally establish the fact that the light had disappeared at a point calculated to have been nearly five miles high, over the northeastern part of Clark County. This point is about twenty to twenty-five miles directly southwest of Greensburg. It was definitely established that its course was something like six or seven degrees from the horizontal. It was also ascertained that the body gave out loud detonations and that it shook buildings so that windows and doors rattled in the towns of Pratt, Haviland, Greensburg, and at other points along its course. No one who was in a position to see accurately could testify to any indication that there was an explosion or bursting of the body where the light disappeared in Clark County.

A visit to Clark County in December brought me into contact with local witnesses to the fall of this body, who were within a few miles of the point where it lost luminosity. It gave out terrible detonations and shone with startling brillancy, but in the darkness no descending body was visible after the light disappeared. At the angle at which the body was traveling it would, if its course continued unchanged, have passed entirely across Clark County and into Meade County. Its line of travel projected would reach the earth in a distance of thirty-eight miles, but allowing for the downward bending of its course under the influence of gravity, it probably came to earth in the west-central part of Clark County. The fact that detonations described as "terrific", "mighty", "powerful", "awful", and the numerous testimonies that windows, doors, and dishes, were violently shaken in towns over which the body passed at an altitude of from ten to fifteen miles, seems to indicate that it is a mass of considerable proportions.

A visit to Clark County in December by three students and myself revealed the fact that its landing place is in one of the roughest areas in the state of Kansas. The abundance of black or reddish brown sandstone boulders renders the finding of the mass quite improbable. A search was, however, carried on during two days, at which time we were driven out by a blizzard.

If any of this meteorite is ever recovered, it seems more likely to be one of the fragments resulting from the explosion which seems to have occurred in the vicinity of Pratt, Kansas. Since this is a cultivated district a considerable sized piece would probably be found by the plow if not too deeply imbedded.

In the course of the investigation, several people testified to having "seen the meteor disappear at a point almost due south and a little east of Greensburg." These people were all located almost directly under the path of the main mass as determined by seemingly unquestionable evidence. A possible interpretation is that the explosion forty miles to the eastward resulted in two or more fragments, one of which was passed to the south of the main course and fell in the vicinity of Coldwater. If so, its velocity must have been such as to develop luminosity after the explosion. There is also evidence that a fragment flew off to the north of the main course and fell north of Greensburg, exploding again near the earth. The evidence of this, however, is less definite.

A NEW KANSAS AEROLITE REFERABLE TO THE FALL OF NOVEMBER 9, 1923

Paper 29 of the 1925 Meeting at Manhattan
(Written December 3, 1924)

H H NININGER
McPherson College, McPherson, Kansas

On October 31, 1924, while on my way to collect fossils in Clark County, in company with Mr. H. T. Martin of Kansas University, I was asked to examine a piece of what appeared to be meteoric stone in the office of the "Western Star" of that village. The stone proved to be a stony meteorite of eleven pounds weight. It had been plowed from a wheat field near by, a few weeks before.

The appearance of the stone led me to think that it was too old to be assigned to the fall of the previous November, being much fractured and of a distinctly reddish-brown color. I assumed that it had undergone a long period of oxidation, but two weeks later when I washed the specimen and examined it more carefully my conclusions were quite different. The original thin crust seemed to be almost completely intact, and shining points of metal projected visibly to the surface at several places on the stone. Microscopic sec-

tions showed that the red coloring was not associated with the very abundant metallic nodules but seemed rather a characteristic of the stony matrix. The fractures proved to be due to impact and not to oxidation.

The location of this stone was fifteen to eighteen miles south of the course of the meteor of November 9, 1923, as I had mapped it eleven months before, and about forty miles down its course from the witnessed explosion in the vicinity of Pratt, from which witnesses averred there were "sparks flew off on both sides". The secondary and incompletely formed fusion crust which covered most of the stone would nicely represent the slight surface fusion which would have developed in those forty miles of flight through the atmosphere after being detached from the main mass. The main mass is known to have retained its luminosity for about fifty-five miles beyond the point of explosion. It is my present opinion that this new Coldwater specimen is assignable to the fall of November 9, 1923, which was described by the author before the Kansas Academy of Science April 5 ,1924.

Pleistocene Fossils from McPherson County, Kansas
1921 TO 1924

Paper 40 of the 1924 Meeting at McPherson
H. H NININGER
McPherson College, McPherson, Kansas

During the last few years a number of interesting fossils have been brought to light in the vicinity of McPherson by excavations which have been carried on, especially in the sand pits of this region. It is thought desirable to record for future reference these various finds, for even though the majority of them present nothing new to science, they contribute to the knowledge of the distribution of such materials, and constitute a permanent record for the use of workers in this part of the state. With the exceptions noted below this material has been submitted to H. T. Martin, of Kansas University, and provisionally classified by him as follows:

HOMO sapiens. The paleolithic axes exhibited to this body in connection with the paper on Archaeology in McPherson County, by Dr. Vance N. Robb, together with several other artefacts classified by Winchell as early neolithic, point at least to the probable existence of man in this region during the pleistocene time.

MASTODON americanus. A milk tooth was found in one of the sand pits one mile south of town several years ago and presented to Dr. V. N. Robb. The crown of the tooth is largely broken away, but the remainder is in an excellent state of preservation. A considerable portion of a tusk was found in the sand pit a mile southeast of town in 1922 and described to me by Allan Morine, a high school boy, who brought me a piece of it. The specimen was described as being about two or two and a half feet long when uncovered, but was broken up and divided among the workmen. The point of a tusk was brought to me from a sand pit 8 miles west of town, and from the same pit was brought a piece of what appears to be the femur of an elephantine animal, and may be of the same species.

ELEPHAS primogenius. This ancient American elephant is widely distributed in Kansas, and has not failed to register its abode in the region of McPhersion. A complete heel-bone (calcaneum) was found during the summer of 1922 in the local sand pit to the south, and was presented to the museum by Samuel Ebbert. Two fine grinding teeth were found while excavating for a septic tank just east of Circle Lake in 1912. During the past winter almost a complete skull was unearthed four miles southwest of Darlow, Kansas. When unearthed it was so badly decayed that only parts of it could be preserved, and those with considerable difficulty. A piece of the skull comprising about two square feet from the forehead was preserved intact and is in the McPherson College museum. This part was doubtless better preserved because of its being buried below the water line.

BISON occidentalis. A calcaneum and two humerals in excellent state of preservation are in our possession. The former from the

sand pit southeast of town and the latter were dug from similar situations near Nickerson and Durham respectively.

EQUUS niobrarensis. Several teeth and a well preserved metacarpal obtained from a sand pit west of McPherson.

EQUSS complicatus(?) One premolar tooth from the locality just described.

EQUUS sp. A very finely preserved digit from the sand pit southeast of McPherson, was found associated with the calcaneum of Eliphas primogenus. This specimen was submitted to the Field Museum, the American Museum, and the University of California, but has not yet been identified with certainty.

CAMELOPS kansanus Of this ancient camel we have obtained from the sand pit southeast of McPherson a portion of a right ulna, a right podial, and a second digit from the left side. From the pit eight miles west, a complete metacarpal, and a large part of a lower jaw with four perfect teeth. These are all well preserved.

MYLODON harlani(?) On December 29, 1924, Mr. H. F. Hammann twelve miles northwest of McPherson unearthed a perfect vertebra of Mylodon. The bone was of such size as to cause him to bring it into town for examination. It was left at the office of the McPherson Republican, and later submitted to me for examination by Mr. Oelrich. It was found to correspond exactly with the sixth caudal vertebra of the mounted skeleton of Mylodon harlani in the McPherson College Museum, except for the fact that it measured about a fifth larger. It was later submitted to Dr. Chester Stock of the University of California, who reported as follows: "I would hesitate to say that the ground sloth specimen represents a species other than harlani for this form, as known by the materials from Rancho La Brea, shows considerable variation in its skeletal structures. It would hardly be safe to make a definite determination on only a caudal vertebra. I should, therefore, be inclined to refer the material to Mylodon, near harlani Owen."

I have been unable to find any definite record of Mylodon remains being previously discovered in Kansas. Williston reports as questionable a fibula from Senaca, Kansas, which he provisionally refers to this species. The McPherson find constitutes at least one definite record of the giant ground sloth from Kansas. Subsequently a visit will be made to the locality from which it was obtained, and a search made for additional material of the same species. The specimen is now preserved in the college museum.

The Problematical Hybrid Grosbeak

Paper 35 of the 1925 Meeting at Manhattan

H. H. NININGER

McPherson College, McPherson, Kansas

While on a field trip with a class in "Birds" on May 12, 1924, my attention was called to a specimen of grosbeak which, at first sight some distance away, I took to be the Black-headed Grosbeak (Zamelodia melancephala), which is the commonest species of grosbeak in the vicinity of McPherson. On closer inspection it became very evident that this opinion was incorrect. But it was equally evident that it could not be the Rose-breast (Zamelodia ludoviciana) which is also found here to some extent. With increasing interest we followed the bird during the next half-hour, and I later returned alone for further study. The trees where it was feeding were low, and it was not in the lease wary, so that with the help of an excellent pair of 4-power binoculars I was able to record a very good description of its coloring.

The head and neck were generally black, but with a slight suffsion of gray and buffy which seemed to be due to the spotting of numerous feather-tips. A rather conspicuous whitish streak ran from the eye back along the side of the head, fading out before reaching the neck. The throat, and to a less extent the chin, were rather strongly lightened by buffy and gray, and none of the head or neck possessed the satiny black lustre of the Rose-breast. The brown collar of the Black-headed Grosbeak was absent. From below the bird looked like the Rose-breast except for a little more streaking along the sides, and in place of the carmine patch was a dull yellow patch of the same shape and size. In the same way the dull yellow was substituted for the carmine under the wings.

In shape the specimen resembled the Rose-breast more closely; and its song was also more closely akin to that species than to the Black-headed, but was more subdued than in either of these species. The behavior of the bird was characteristically that of the Black-headed Grosbeak.

I am at a loss whether to consider this as a hybrid or a mutant Rose-breast Grosbeak. The facts have been carefully set down, and I should appreciate reading the comments of others who may have seen additional specimens of this kind, or who may have some light to throw upon the question.

THE BULLOCK ORIOLE IN KANSAS

Paper 36 of the 1925 Meeting at Manhattan

H. H NININGER
McPherson College, McPherson, Kansas

The Bullock Oriole (Icterus bullocki) has been reported within the state of Kansas by F. H. Snow, basing his statement on two specimens taken in 1871 along the Wakarusa river near Lawrence, Kansas. This record has been questioned by Professor Lantz, but was reasserted by Professor Snow in 1903 in his "Notes on the Birds of Kansas and a Revised Catalog". It is in this catalog given the status of a very rare summer resident. Captain B. F. Goss, in his "Birds of Kansas", quotes Professor Cook as saying that this species is common in western Kansas during migration, and that it has been seen as far eastward as Manhattan in 1883; but Goss states that he has never met with the birds within the state and therefore considers its occurrence very rare.

On June 6, 1924, while en route to Colorado, the writer's attention was attracted to a pair of these orioles on a wire fence along the pavement just beyond Garden City. In order to verify this observation, I stopped the car and examined the birds carefully through a pair of good binoculars, and identified them with certainty as the species above named. It having been my first meeting with this species in Kansas, I kept watching for other individuals along the highway, and to my surprise was able to count seven between Garden City and the western Kansas line. On one other occasion besides the one mentioned, the car was stopped to verify the identification of two of these birds.

The fact that so many individuals were seen so late in the season, and the further fact that in all but one case these were seen in pairs, leads me to suspect that the Bullock Oriole is a summer resident of western Kansas. Though this speculation has not been verified, it is certain that the species named may not any longer be considered rare within the state.

To the mind of the writer it is not impossible that the agricultural developments of the last forty years in the vicinity of Garden City may have some influence in the extension of this bird's range. However, the matter has not been given sufficient attention to justify conclusions, and I suggest it as a subject for further observation.

A New Record Relative to the Parasites of Pholus achemon Drury

Paper 24 of the 1927 Meet ng at Lawrence

HAZEL E BRANCH

Univers ty of Wichita, Wichita, Kansas

In the spring of 1924, at Wichita, Kansas, a tachinid, identified by Dr. Luther West as Frontina violenta Walk. was bred from Pholus achemon Drury.

Frontina violenta Walk. has been taken from Philampelus vitis L. and Vanessa antiopa L. while Sturmia distincta Wied. and Winthemia quadripustulata Fabr. have been taken from Pholus achemon Drury, but as far as we have been able to ascertain this is a new record. In the fall of 1923 the caterpillars of Pholus achemon Drury upon the woodbine were found to have fly eggs upon the skin of the last three or four segments. As we were not interested in parasites, but in moths, we attempted to remove these eggs. All but one specimen cleaned well. Each specimen was placed in a separate jar with dirt and leaves and pupated normally, including the one from which the fly eggs could not be removed.

In the spring of 1924, moths emerged in March from the jars in which the cleaned caterpillars had pupated. From the jar of the caterpillar which could not be cleaned, flies emerged. This emergence took place about four or five days after the moths made their emergence, and continued for about four days. When the emergence ceased we killed and mounted the flies and made an observation on the pupal case of the host. This case was found ruptured, and literally packed full with the pupal cases of the flies.

We have attempted to repeat this observation, but the laws of parasitism are in force and our host is on the decline. A few caterpillars are found, but these are either not parasited, or else another factor is at work. Harold Hefley of Norman, Oklahoma, has discovered a temperature-humidity relationship between the parasite Winthemia quadripustulata and its host Protoparce quinquefasciata, and as soon as specimens are abundant we hope to make similar investigations.

A Study of the Components of Air in Relation to Animal Life

Abstract of Papers, 42 (1924), 51 (1925), 25 (1926), 17a (1927) and 21 & 22 (1928).

J. WILLARD HERSHEY
McPherson College, McPherson, Kansas

Oxygen, since the time of Lavoisier, has been considered the vital component of the air. The 79.19 per cent inert part has had little use assigned to it. Popular opinion had stated that animal life would be more efficient if these inert gases were replaced by oxygen.

Carefully conducted experiments, covering a period of six years, have shown the following truths in regard to animal life and the components of the air.

Animals can not live in an atmosphere alone of oxygen, nitrogen, carbon-dioxide, helium, or argon. A series of thirty experiments, using representative vaieties of animal life, has shown that in an atmosphere of pure oxygen, with other conditions normal, life would cease after two to five days. In no case did any of the animals live over a week in oxygen, while in the current of air we had them confined from one to three weeks without any signs of ailments. With the animals such as sparrows, pigeons, mice, rats, cats, guinea pigs, and monkeys, without a single exception, every one died in oxygen and none in air. As could be expected, the inert gases would not support life.

Autopsy Shows Hemorrhage

An examination of the lung tissue from a guinea pig, which had died in an atmosphere of pure oxygen, showed marked evidences of inflamation and interstitial hemorrhage.

Cultures made from lung tissue showed a heavy infection of Bacillus coli associated with a few Staphylocicci. The conclusion drawn from the autopsy was that an atmosphere of oxygen would not only rupture the lung tissue but accelerate the growth of certain micro-organisms.

Carbon-dioxide and Oxygen

Animals were placed in an atmosphere of 99.97 per cent oxygen and the normal .03 per cent carbon-dioxide. The animals used for this series of experiments were guinea pigs. Death followed within two days to five days as in the oxygen experiments.

The Effect of Pure Oxygen upon Water Animals

The experiments were continued with water animals in pure oxygen which was passed continually through the water. The animals for these experiments were fish, tad-poles, snails, newts, and turtles. These water animals tested just the opposite from the land animals. In this case the pure oxygen could not have had such a burning effect when diluted with water which also soon became saturated with carbon-dioxide.

Argon and Oxygen Atmosphere

An atmosphere was prepared which contained 87 per cent argon and 13 per cent oxygen. Mice lived forty-two hours under this condition. The respiration of the animals decreased slowly until death.

Argon 80 per cent and oxygen 20 per cent permitted life for ninety-two hours.

Argon 75 per cent and oxygen 25 per cent permitted normal life. After ten days of confinement the animals appeared in better health than before the experiment.

An atmosphere made up of 66 2-3 per cent argon and 33 1-3 per cent oxygen supported life. The animals after seven days confinement were in poor health. The point of highest efficiency had apparently been passed.

Helium Atmosphere

Helium 79 per cent and oxygen 21 per cent form an atmosphere under which animal life may exist normally.

The high specific gravity, 1.38 (air), of argon gas probably accounts for its behaviour as an oxygen diluting agent. Experiments must be carried further before a scientific conclusion can be reached.

The preparation of synthetic atmosphere has practical applications in the field of aviation. Tubes of compressed oxygen and helum may some day furnish the respiration gases for high flying.

The study of the physiological effects of the air gases has only begun. We are continuing the experiments here on the components of the air for further information along this same line.

A Study of Birth Weights with Relation to the Age of Mother and Season of Birth

Paper 31 of the 1928 Meeting at Wichita
HELEN W. FORD
Kansas State Agricultural College, Manhattan, Kansas

Although many studies have been reported on birth weights of infants with relation to age of mother and season of birth, further studies seem to be necessary in order to settle certain disputed points. In view of this fact a study was made by the author of the relation of these factors to the weights at birth of 3554 white infants as entered on the records of several hospitals and clinics in the eastern part of the United States.

First, as regards birth weights in relation to age of the mother, we find a fair amount of agreement among authorities that birth weights tend to increase with the mother's age. Some authors however have reported no relation between age of mother and weight of infant or a greater weight for infants of younger mothers. But several of these reports were made years ago when it is probable that weights were taken less accurately than now, or they were based on a smaller number of cases.

Williams says, "The size of the foetus increases with the age of the mother up to the 28th or 30th year if pregnacies have not followed in too rapid succession." Other authorities have found that the weights of children at birth continue to increase with the age of the mother even up to the 44th year.

It is understood that other factors such as size of parents and the care and environment of the mother during pregnancy as well as the number of previous pregnancies may explain differences in birth weights. Because of the definitely lower weight of negro as compared with white infants, the author has omitted negro births from this study. Race and nationality factors also affect birth weights, but since it is almost impossible to adjust for these factors, even when the mothers are divided according to nativity, the group was studied as a whole. Further studies of births to thousands of mothers of the same age and nationality are obviously much needed.

Groups were used in finding the average birth weights for infants of mothers of different ages. Within each age group, for example, the proportion of infants in each of five weight groups served to give the average weight for that age group. The average birth weights thus found are given in the following table:

Age of Mother	Birth Weight of infant
15 to 19 years	3379 grams
20 to 24 years	3390 grams
25 to 29 years	3584 grams
30 to 34 years	3608 grams
35 to 39 years	3640 grams
40 years and over	3630 grams

A somewhat higher proportion of Italian and Irish mothers among the older age groups might account partly for the heavier weights of infants born to the older mothers.

It is of interest to notice the percent of infants of various weights born to mothers in each age group.

Per Cent of Birth Weights at Different Ages of the Mothers

Infant's wt.	15-19 yr.	20-24 yr.	25-29 yr.	30-34 yr.	35-39 yr.	40 & up
1500 - 2499 g.	2.9— .7*	6.1— .5*	2.4— .3*	3.1— .4*	4.4— .6*	3.6—1.1*
2500 - 2999 g.	21.5—1.8	15.3— .8	9.4— .5	9.5— .7	8.5— .9	12.6—2.0
3000 - 3499 g.	44.8—2.2	34.6—1.1	29.8— .9	26.6—1.1	21.9—1.4	21.6—2.5
3500 - 3999 g.	23.9—1.9	28.9—1.1	34.2— .9	31.5—1.1	32.9—1.5	25.2—2.7
4000 - and over	6.8—1.1	15.3— .8	24.2— .8	29.4—1.1	32.3—1.5	37.0—3.0

*Percentages cited have a probable error plus or minus as listed in starred column.

It will be noticed that the proportion of mothers in each age group who give birth to the heaviest infants increases consistently with the age of the mothers, from 6.8 per cent for the mothers of 15 to 19 years of age up to 32.3 and 37.0 percents respectively for mothers who are over 35 and 40 years of age. On the other hand there is a general tendency for the proportion of small infants of 2500-2999 grams to decrease with the age of the mother up to 39 years.

Another factor that has been studied with varying conclusions has been the matter of variation in birth weights according to season of birth. Some investigators have reported little or no variation while others have reported heavier weights for infants born during the summer months.

The average weights based rather on group than on individual averages were found to be as follows: for infants born in the spring, 3547 grams; for those born in the summer 3540 grams; in the fall 3580 grams; in the winter 3547 grams. These figures show no significant seasonal variation increase in the fall being only slightly above the other weights. These findings are in general agreement with those of Hellmuth, who found among 26,515 births no fluctuation of weights according to season of birth. The following table gives the percents of births of various weights occuring in each season:

Births According to Weight and Season of Birth

Season of birth.	1500 - 2499 g.	2500 - 2999 g.	3000 - 3499 g.	3500 - 3999 g.	4000 g. and up
	*	*	*	*	*
Spring	33.0—3.2	25.2—1.5	27.8—.9	25.4—.8	26.0—1.
Summer	23.4—2.9	2[illegible].5—1.5	24.5—.8	25.9—.8	25.0—1.
Fall	18.1—2.4	24.3—1.5	23.9—.8	24.4—.8	25.8—1.
Winter	25.5—2.9	24.9—1.5	23.9—.8	24.2—.8	25.4—1.

*Percentages cited have a probable error plus or minus as listed in starred column

When account is taken of the probable error in each case, it will be seen that the differences in the proportion of heavy and light infants in the different seasons are negligible. Only in the group of infants under 2500 grams do we find significant differences after the probable error is considered. We find that 33 percent of the infants of this group were born in the spring as compared with only 18 percent born in the fall and 23 percent born in the summer. The smaller number of infants in this group, however, as well as the many possible factors that play a part in causing premature births make these percents less reliable. Further studies of the possible relation of seasonal factors to prematurity are much needed. It has been shown that the presence during pregnancy of symptons that often indicate mild toxemias is associated with a prematurity rate for the infants of these mothers that is from two to six times the normal rate. It would seem quite possible that the winter and early spring diet of the mothers which is often high in meat and low in fruit and vegetable content might account partly for a higher proportion of infants under 2500 grams being born in the spring.

Glacial Erratics in Shawnee, Douglas and Johnson Counties, Kansas

Paper 6 of the 1924 Meeting at McPherson

WALTER H. SCHOEWE
University of Kansas, Lawrence, Kansas

The presence of some glacial erratics in Wabaunsee, Shawnee, Douglas and Johnson counties south of the line marking the position of the maximum advance of the Kansas ice sheet has been known for a long time. These deposits have been interpreted as outwash materials some of which were supposed to have formed while the glacier advanced and others while it retreated.* During the recent investigations many new exposures of glacial pebbles and boulders were located and mapped. See Plate I. The erratics consist of pebbles and boulders of various kinds and sizes. The following list comprises the most important rock types which are represented: red and white quartzizites and quartzite conglomerates, fine and coarse grained granites, mica and horblend schists, diorites, gabbros, gneiss, basalt, iron-bearing rocks, chet, quartz, petrified wood, and local sandstones, shales and limestones.

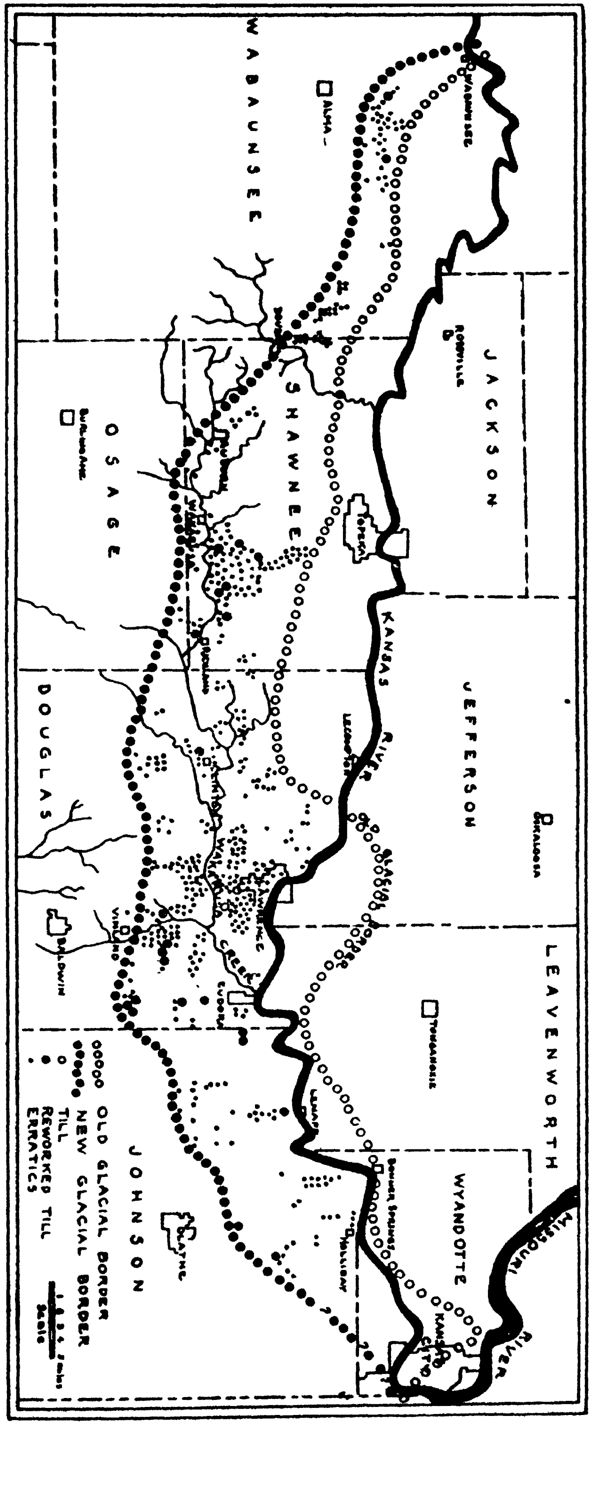
Of the boulders, the pink to red quartzites and quartzite conglomerates are the most conspicuous and numerous and in many places constitute from 75 to 90 per cent of all the boulders present. These erratics are generally very hard, smoothly rounded and more or less polished. Some, however, are unusually well weathered, breaking down to sugar-like quartz grains when slight pressure is applied. The granites are represented by two types and next to the quartzites are the most abundant. One of the types is a light colored medium to fine-grained rock, whereas the other is coarser grained and generally of a reddish color. In size, both the quartzites and the granites vary greatly, ranging from mere pebbles to boulders over six feet in their longest dimensions. Many of the granites crumble to pieces of feldspar and quartz very readily, others are relatively firm. In general, the granites all show the effects of weathering much more than do the quartzites.

The darker igneous rocks, such as the gabbros, diorites and basalts all show characteristic subangular forms and a stage of disintegation and decomposition intermediate between the quartzites and the granites. These rocks as well as the schists and others mentioned above are less numerous that the two types firrst described. The local rocks are not well represented.

A study of the erratics shows at least six facts. (1) The erratics are much more numerous than is indicated in the literature. Erratic

*J. E. Todd, "Kansas During the Ice Age" Trans. Kansas Acad Sci., Vol. XXVIII,(1917), pp 39-44.

PLATE I



MAP SHOWING THE DISTRIBUTION OF GLACIAL ERRATICS AND EXTENT OF THE ICE SHEET SOUTH OF KANSAS RIVER

boulders have been described as being scattered as far south as 38 degrees, 50 minutes and pebbles to 38 degrees* North Latitude.

It is very doubtful, however, if most of these erratics can be ascribed to the glacial invasion. More likely they were carried eastward by streams coming from the Tertiary sand and gravel plains or else, as intimated by Chamberlin,** may be due to glacio-fluvial action. Todd*** has mapped and described eight localities where erratics occur south of his glacial border. A glance at the map shown on Plate I indicates that exposures of erratics are very numerous.

(2) Of more importance than the mere number of exposures of glacial drift is the fact that the erratics are very widespread and have a far greater areal distribution than is indicated on the published maps. This wide areal distribution of the northern pebbles and boulders does not harmonize well with the fluvial or glacio-fluvial hypothesis advanced to account for the few more or less restricted areas of erratics. Undoubted outwash deposits occur in the region under discussion. However, it is not reasonable to suppose that an ice sheet like the Kansan which in Kansas left only more or less patchy and thin deposits without the development of a pronounced terminal moraine**** should have distributed most of its load by means of streams coming from the melting ice sheet and should have deposited the materials over an area as widespread as that shown on the map. (Plate I).

(3) The erratics are just as numerous at a distance south of the mapped glacial border as near it. This together with the fact that (4) there is no sorting or separation of large and small materials as they are traced away from the glacial border appears to indicate direct ice action rather than stream deposition. Streams usually sort their materials.

Although the sorting may be poor, yet a more or less change in the sizes of the pebbles and boulders should be noticeable as they are traced fartehr and farther away from the glacial border. This, however, is contrary to the facts. Also, not only should there be a noticeable difference in the sizes of the materials carried down stream but the boulders and pebbles should become less numerous in the same direction. This also is not evidenced in the field. Almost everywhere in the region immediately north of the glacial border

*B. F. Mudge, Fourth Agricultural Report and Census, Kansas, (1875), p. 109; T. C Chamberlin and R D. Salisbury, "Prel minary Paper on the Driftless Area of the Upper Mississippi Valley." U. S. Geol. Survey Sixth Ann Rept., (1883), p. 314.

**T. C. Chamberlin and R. D. Salisbury, op. cit, p. 314.

***J. E. Todd, "Glacial Geology of Kansas", unpublished manuscript; Plate XI "Map of Pleistocene Formations of Northeastern Kansas," Pan-American Geologist, Vol. XL, (1923).

****J. E. Todd, "Kansas During the Ice Age." Kansas Acad. Sci., Vol. XXVIII, (1917), pp. 35, 37.

the drift is thin and at many places patchy and often represented only by scattered boulders. In fact, the country between Topeka and the glacial border west of Lawrence (see map) shows no more conclusive evidence of glaciation than the region south of it. Unless the topography at the time of the ice invasion was entirely different from what it is now, the streams coming from the melting glacier could not have had a high gradient and therefore should have dropped more and larger boulders near the ice edge and carried the smaller ones farther away.

(5) The erratics are not confined to any tapographic position neither are they limited in elevation. Some are found in the valleys others on the slopes and still others on the uplands. The previously known drift was mapped as occuring in strips or else confined to definite channels in the region of the Wakurasa Valley.* as indicated before, the erratics are now known to be widespread and careful checking of barometric readings made at the exposures show variations of 30, 50, and more than 100 feet within short distances. Streams usually deposit their materials along definite channels and in such a manner that practically very little difference in elevation exists within short distances. Therefore, the disregard for elevation together with the lack of definite arrangement or distribution of the deposits favor direct deposition by the ice rather than by streams coming from the glacier.

(6) According to the previous mapping* the ice sheet crossed the valley of the Kansas River about seven miles northwest of Lawrence. Between that point and Kansas City the valley was unoccupied by the ice. It is therefore difficult to account for the numerous and widespread erratics south of the river between the two cities mentioned above for between the erratics and the melting ice sheet lay the trough of the river which undoubtedly must have served as the main outlet for the drainage coming from the glacier.

In conclusion, the writer is convinced from his study of the erratics that an ice sheet extended beyond the limits of the mapped glacial border and reached as far south as is indicated on the accompanying map, Plate I.

*J. E. Todd, "Kansas During the Ice Age", Trans. Kansas Acad Sci Vol XXVIII, (1917), p. 36; Plate XI "Map of Pleistocene Formations of Northeastern Kansas." Pan-American Geologist, Vol. XL, (1923).

**J. E. Todd, op. cit., Map 1, Plate XI.

Additional Evidences of an Ice Invasion South of Kansas River in Eastern Kansas

Paper 26a of the 1927 Meeting at Lawrence

WALTER H. SCHOEWE
University of Kansas, Lawrence, Kansas

In a paper "Glacial Erratics in Shawnee, Douglas and Johnson counties, Kansas", read before the Kansas Academy of Science in 1924, the conclusion was reached from a study of glacial erratics that

an ice sheet extended beyond the limits of the previously mapped glacial border in Eastern Kansas. Since that time, field investigations carried on in the region of the attenuated drift border have yielded additional evidences of the ice extension. The evidences are (1) true till, (2) reworked till, and (3) glacial striae.

True Till Deposits

Undoubted evidence of the extension of the ice sheet is established by the finding of true till at two localities. The first of the two exposures is at Haskell Indian Institute located at the south city limits of Lawrence and eleven miles south of Todd's glacial border. The other deposit is three-fourths of a mile south and one mile east of the Haskell locality in the northeast corner of NE 1-4, sec. 17, T. 13S, R. 20E. Except for the presence of numerous erratics lying scattered over the surface no indications of an existing till at the two localities were to be seen. In each case the till was discovered through the process of excavating. The Haskell deposit was uncovered at the time of the building of the Haskell stadium while leveling the athletic field by means of the steam shovel, digging trenches for drainage purposes and sites for foundations. At the western edge of the athletic field the overburden was removed from an area of about an acre and to a depth of five feet. The excavation thus made revealed a true till. A better exposure, however, was brought to light in a trench from ten to twelve feet deep dug on the south side of the west end of the athletic field. Here, although less of an exposure, the material was to be seen at a better advantage because the till was undisturbed. The following materials were exposed:

1.	Black loamy soil	2 feet	inches
2.	Red sandy soil	2 feet	inches
3.	Band of black silt or soil, containing an occasional quartzite pebble and grading gradually and irregularly into the till beneath, from		6 - 12 inches
4.	Very red, tough till, thoroughly leached and filled with erratics of various kinds and sizes, exposed to bottom of trench	8 feet	inches

The erratics in the tough red till ranged in size from pebbles less than one-fourth of an inch to boulders one foot in diameter and consisted chiefly of red to pink quartzites with some well decayed granites and greenstones. There are two tills representd in the above section. The upper till is decidedly different from the lower one in being less clayey, thinner and containing erratics much smaller in size. The two tills are separated by the black silty band or soil indicated in the section. This deposit is at the edge of the upland overlooking the valley of Wakarusa Creek and about 50 feet above its flood plain.

The other deposit of till to the southeast of the one just described is essentially similar to the lower eight feet of the Haskell exposure, excepting that granites and greenstones are more abundant and on the average larger. This deposit is also on the upland overlooking Wakarusa Valley and is at an elevation of 870 feet above sea level

or 10 feet lower than the one first described. As in the first case, numerous quartzite boulders dotted the surface without showing any traces of a till beneath. The till was discovered while digging a trench four feet deep to the top of the Western Sandstone.

Although only two localities of true till have thus far been located other deposits undoubtedly exist hidden as those just described and only through the building of new roads, excavations for foundation sites and drainage ditches will they eventually come to light.

Reworked Till Deposits

Although true till deposits are scarce, deposits of till partially reworked by rain, gravity and other agents are fairly numerous and widely scattered. It was the finding of these till-like deposits that first aroused the writer's interest and attention to the possible extension of the ice sheet in Kansas. The material at the till-like outcrops is exposed in road cuts from 100 to 200 feet long and generally about three feet deep. In all cases the drift is composed of a brown to red, more or less sandy, often sticky clayey material, thoroughly leached and containing numerous pebbles and boulders. The coarse materials consist chiefly of red quartzite, well decayed granites, brown to white cherts some of which crumble to a fine white powder on even the slightest pressure, gneisses, schists and sandstones. In size the pebbles average less than one-half of an inch in diameter. The larger boulders measure from one to two feet in diameter and consist for the most part of red Sioux quartzites. A loess-like silt covers the deposits in most places. The deposits just described are without question tills which subsequently have been reworked. This is evidenced by the partial rearrangement of the materials into irregular layers of pebbles and boulders following the contour of the topography. The materials show no true stratification. The position of the deposits on the uplands and divides also precludes any other origin but glacial deposition.

Glacial Striae

A third evidence of the ice extension is indicated by the presence of glacial striae several miles east of Eudora and located south of the mapped glacial border. These striae were not observed by the writer but were reported to him by Dr. Twenhofel of the University of Wisconsin who had seen them a number of years ago.

Summary and Conclusion

Summing up the evidences of the tills both the true and the reworked deposits, the glacial striae beyond the limits of the old glacial border and the erratics previously reported, the writer is convinced that an ice sheet extended beyond the limits of the mapped glacial border and reached as far south as is indicated on the accompanying map, Plate I.

Evidences of Stream Piracy on the Dakota Hogback Between Golden and Morrison, Colorado

Paper 32 of the 1925 Meeting at Manhattan

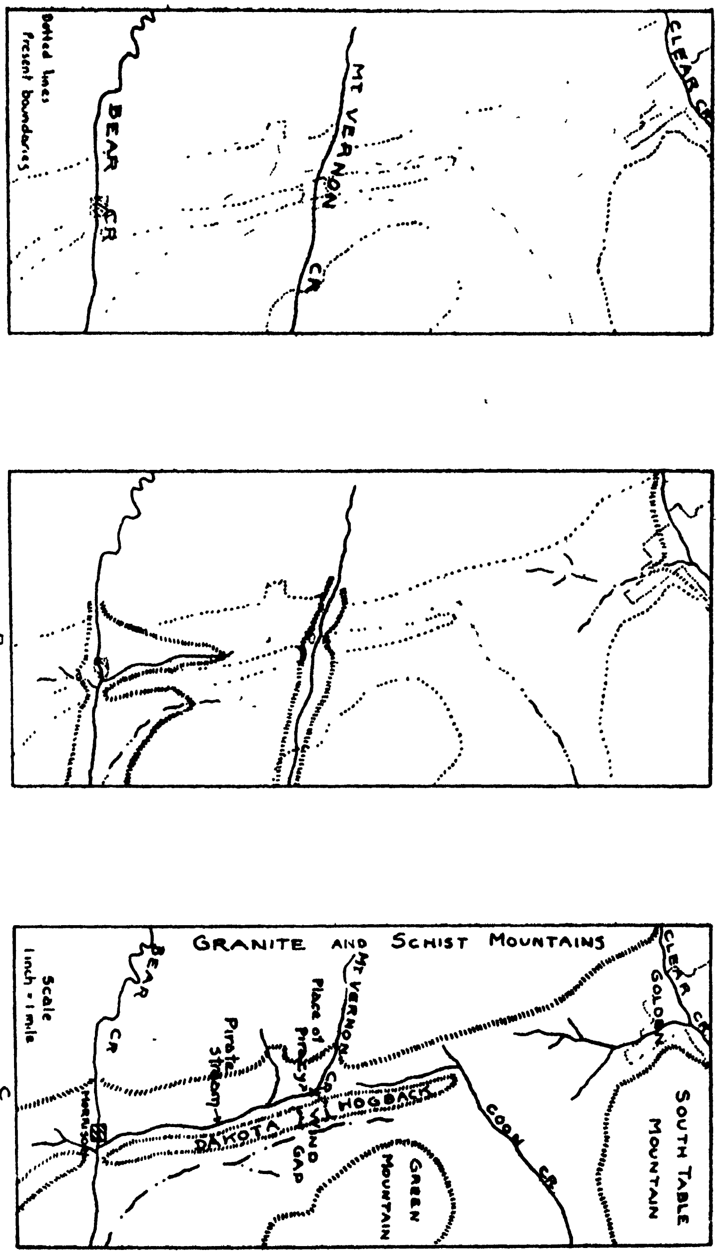
WALTER H SCHOEWE
University of Kansas, Lawrence, Kansas

Flanking the pre-Cambrian granite mountains of the Front Range in Colorado are a series of upturned sedimentary rocks—sandstones, shales, and conglomerates ranging in age from Pennsylvanian to early Tertiary. Streams have deeply eroded the region and because of the unequally resistant character of the formations to erosion a system of longitudinal valleys have been developed in the weaker rocks. The uneroded and resistant formations have given rise to the more conspicuous topographic features of the region, namely long and narrow parallel ridges or hogbacks.

Between Golden and Morrison are several hogbacks. Of these, the Dakota hogback is the most prominent one. Its name is derived from the fact that the thick sandstone beds of the Dakota formation cap its summit. This hogback is continuous without a break for the entire distance of four and one-half miles between the two places mentioned. A sag or gap in the otherwise even sky line at a point about four miles south of Golden is the outstanding and noticeable feature of the ridge. The gap is 520 feet long, 435 feet wide, 105 feet deep, and between 300 and 400 feet above the valley floor on either side of the hogback. A study of the gap and its materials brings to light very interesting facts. First: the boulders lying scattered over the even floor of the gap consist of erratic materials, rocks of igneous and metamorphic origin, whereas the gap is cut in sedimentary formations. The boulders consist of various kinds of schist, granite and vein quartz, and range in size from three inches to over two feet. Second: the boulders are subangular to rounded in shape indicating at least some transportation. Third: the boulders are limited to the gap. Fourth: the boulders are far above the reaches of any stream. Fifth: the floor of the gap is practically level and the walls of the gap are well defiined and fairly steep. Sixth: practically no weathered or talus blocks of the sedimentary formations are found in the gap. Seventh: an examination of the rocks of the pre-Cambrian mountains to the west of the hogback reveals rocks similar to those seen in the gap. Eighth: the gap is in a direct line with Mt. Vernon canyon of the mountains to the west, the outlet of the main north tributary of Bear Creek, the master stream of the region.

Conclusion: The only satisfactory explanation that can account for the gap together with the erratic boulders contained in it is that a stream formerly flowed through the gap and deposited the boulders in it. The surface of the region at that time was approximately 400 feet higher than it is now. The abandonment of the gap by the stream was caused by a change in the stream's course due to stream piracy.

PLATE 1



A
ORIGINAL COURSES OF STREAMS

B
DEVELOPMENT OF TRIBUTARIES

C
PRESENT COURSES OF STREAMS

History: After the deposition of the various sedimentary formations uplift occurred resulting in the arching of the sedimentary strata over the floor of the ancient igneous and metamorphic pre-Cambrian rocks. This uplift took place sometime during the Tertiary as early Tertiary sediments are involved in the folding. Streams soon established their courses and followed the easterly slope toward the Great Plains. See A, fig. 1. Because of certain advantages such as greater volume, greater velocity or less resistant formations to work in, Bear Creek gained the advantage over the other streams and became the master stream of the region. As a result, Bear Creek sunk its channel deeper and more quickly through the more resistant formations than did Mt. Vernon creek farther to the north. A north tributary of Bear Creek developed on the softer rocks and extended its valley northward by head erosion. See B, fig. 1. Because this tributary was cutting parallel to the strike in the softer formations and was keeping pace with the master stream ,it was able to sink its channel more quickly and thus lower its valley more readily than the east flowing Mt. Vernon creek which flowed across the alternating hard and soft upturned edges of the sedimentary formations. As a result the north tributary of Bear Creek captured or tapped the waters of Mt. Vernon creek changing the direction of flow from east to south. The north tributary of Bear Creek thus became the pirate stream and Mt. Vernon creek the captured, diverted and beheaded stream. See C, fig. 1. The changing of the stream's course resulted in the abandonment of the gap and its conversion into a wind gap. Continued erosion lowered the valley floor of the pirate stream until today the stream flows from 300 to 400 feet below the former level of Mt. Vernon creek.

The Amphibians and Reptiles of Franklin County, Kansas*

Paper 10 of the 1926 Meeting at Winfield
HOWARD K. GLOYD
Kansas State Agricultural College, Manhattan, Kansas

From the spring of 1924 to the fall of 1927, more than 1500 specimens of amphibians and reptiles were collected in Franklin County, Kansas, by the writer and some of his students at Ottawa University. Forty-seven species and subspecies (nine amphibians, six lizards, twenty-six snakes and six turtles) are represented. While this field work was being done, observations were made on the habitats, behavior and life histories of the forms secured. Because a change in residence has been made it seems best that these notes should be published.

The region in which these studies were made consists of almost the entire area of Franklin County. The Marais des Cygnes River passes approximately from west to east across the northern half of the county, and with its many branches produces a large number of small wooded valleys with rocky hillsides and occasional limestone or sandstone cliffs ranging in height from ten to fifty feet. The only prairie of any extent is found in the southwestern portion of the county, across the southern end of a chain of highlands known as the Chippewa Hills. Here in several places are outcroppings of sandstone. In the eastern and southern part of the county the rock formations along the streams are limestone. Along the valleys of these small streams open timber is found, the predominating trees being oak, ash, elm, and hickory with a few old cedars in the rocky bluffs. In the valley of the Marais des Cygnes it is still possible to find small marshy ponds, depressions in the flood plain, in which enough water is present most of the year to furnish breeding places for an abundance of frogs and toads. These little spots are reminiscent of the days before much of the land was brought under cultivation, when the Marais des Cygnes valley was truly a "Marsh of Swans".

Specimens of each form have been preserved in the musuem of Ottawa University, and museum numbers here given, following the letters O. U. M., refer to this collection. Much of the material secured during this period, however, was exchanged or used for other purposes.

Early papers dealing with Kansas herpetology are very few in number. Mozley (1878) listed the snakes in the museum of the University of Kansas and four papers by Cragin (1881, 1884, 1885 and 1894) gave miscellaneous records on the distribution of Kansas amphibians and reptiles. None of these gave any records from Frank-

*Contribution from the Department of Biology, Ottawa University, Ottawa, Kansas. The writer wishes to thank Dr. F. Erdmann Smith, President of Ottawa University, and Dr. W. B. Wilson, head of the Department of Biology, for making it possible for him to carry on herpetological studies at that institution.

lin County. Branson in his paper on the snakes of Kansas (1904) reported from this locality sixteen species which will be referred to later. To the knowledge of the writer, no other papers on the herpetology of Franklin County or adjacent regions have been published.

No attempt has been made to discuss in detail the food habits of the species treated in this paper. Since the notes on this subject are simply records of the writer's experience in keeping many of these animals alive for various periods of time, the literature on food habits has not been reviewed. In connection with certain species about which little is known, it is believed that these incomplete studies may be of value.

For assistance in the field and laboratory the writer is especially grateful to Mrs. Leonora K. Gloyd, Mr. George W. Saip and Mr. Wilbur Doudna. Mr. Wesley Clanton assisted as a collector and contributed data for which the writer is greatly indebted. The kindness of Dr. Frank N. Blanchard, of the University of Michigan, in identifying specimens and giving many helpful suggestions while this manuscript was in preparation is greatly appreciated.

AMPHIBIANS

Most of the amphibian collecting was done at night with the aid of an acetylene head-light with a gentrator attached to the belt. This was found to have several advantages over various electric flashlights and gasoline lanterns which were used on certain occasions. It left both hands free for manipulating collecting apparatus and cloth bag containers. The eyes of frogs and toads reflected the light from such a source at distances from ten to fifty yards, depending upon the size of the animal. Species as small as Hyla versicolor were readily located at moderate distances by this means. With proper caution, avoiding floating and submerged debris and unusual splashing of the water, it was usually possible to catch the specimens by hand.

1. Necturus maculosus (Rafinesque). Mudpuppy; Waterdog.

Two specimens of this form were taken on trot lines in the Marais des Cygnes River April 15 and April 18. Local fishermen state that they are frequently captured in this way. O. U. M. 325, 326.

2. Ambystoma texanum Matthes. Texan Salamander.

This species was frequently taken in early March from shallow pasture streams which after the spring rains connect grassy pools, drying up almost completely during the summer. Eggs and newly hatched larvae were collected March 1. An adult was found in a crayfish hole near a pond May 15, another under a board October 28, and another as late as November 10. O. U. M. 301-303, 734, 735.

3. Bufo americanus Holbrook. Common Toad.

These toads in 1927 were first collected March 30, and a clasping pair was found among those secured. By April 4 toads were singing in full chorus in ponds and marshes. Several clasping pairs were taken, one of which deposited eggs in a laboratory aquarium April 5. Large numbers were again seen and heard April 9, although a care-

ful search for mated pairs revealed none. Young toads were undergoing metamorphosis in shallow ponds May 24 and adults were heard singing June 2. O. U. M. 142-159.

4. Acris gryllus (Le Conte). Cricket Frog.

The cricket frog was found to be abundant in this region and commonly seen near ponds and streams from the latter part of March to September. The earliest singing date noted was April 9. It sang more or less sporadically throughout the summer. It was collected as early as February 5 (in this case being seen through the thin ice in a small stream) and as late as December 3. O. U. M. 328-331, 341-363.

5. Pseudacris triseriata (Weid). Swamp Tree Frog.

The notes of the swamp tree frogs were sometimes heard during the first week of February, when they appeared as soon as a slight moderation in weather and rise in temperature permitted. Periods of cold weather sent them into shelter for a time but they promptly emerged and resumed their chorus as soon as the water temperature was slightly above freezing. Mated pairs were collected and egg masses attached to plant stems in water were observed March 6. By March 10 very large numbers were singing in every pond, creek and marsh in the vicinity. A spawning pair was observed the night of March 14. The female was clinging back downward to a weed stalk four or five inches beneath the surface of the water, the forelegs of the male clasping her in the armpits. As the eggs were extruded their gelatinous coverings adhered to the supporting stem. Mated pairs were collected April 9 and singing was still heard. On this date also a frog of this species was taken from the mouth of a large leopard frog, Rana pipiens. Tadpoles of the swamp tree frog were transforming May 15. O. U. M. 332-340, 786-813, 853-863.

6. Hyla versicolor versicolor (Le Conte). Common Tree Frog.

The earliest date on which this species was heard singing was April 9 when it was collected near Ottawa in a small cat-tail and sedge marsh bordered by a few low, overhanging trees. About twenty-five specimens were secured but comparatively small numbers were singing. They were taken from the water, where they floated on the surface or clung to partly submerged plant stems, and from the trunks and branches of trees. Singing males were found in both places. About a third of the catch proved to be females but only one clasping pair was secured. On several occasions later in the season isolated individuals were heard singing. O. U. M. 888-909.

7. Rana areolata Baird & Girard. Northern Gopher Frog.

This species was much more common in this region than is ordinarily supposed; its cry, if not the frog itself, being familiar to almost everyone who listens to frog voices in the spring. It was much more wary and difficult to catch than any other species of the vicinity, and perhaps this habitual shyness, and the fact that it remains quiet throughout the day and in or near its burrow all the year except

during the breeding season, may account for its being so little known. As observed in Franklin County, it began to sing about the middle of March and continued to sing a relatively short time. It was not heard after the middle of April. The earliest specimens were taken March 11 and, in 1927, it was last heard singing April 9. It occurred most often in shallow, grass-grown pools formed in pastures and meadows by standing water after spring rains. Males were usually more abundant than females. Often in a catch of twenty or thirty only one or two females were present.

The song of Rana areolata was most often heard after dark although on one occasion several were singing and splashing in a road side pond about an hour before sundown. The voice of these frogs does not have the prolonged resonance of that of the bullfrog, R. catesbeiana, although it is almost as deep and seems to have even more carrying power. The song most frequently heard is a low-pitched, drawn-out gutteral note which may be suggested by the syllables "wurr-r-r-up" accented on the last. It is repeated several times, either from the surface of the water or from the shore, at more or less regular intervals, varying in frequency. The vocal sacs of the males are lateral and relatively much larger than those of R. pipiens. When singing they are distended until they resemble minature balloons, each one almost as large as the head itself.

During the height of the breeding activities the song of the male was varied considerably from what has just been described. On a few occasions, once in daylight about 6:30 p. m., and at other times between dark and midnight, two or three males were observed with vocal sacs and belly inflated, bobbing up and down and splashing about on the surface of the water, accompanying these performances by much chuckling and croaking very unlike their usual song. They floated on the surface, paddling about with their hind feet, their short legs seemingly held rigid with knee joints slightly flexed. Occasionlly one would make a rush at another which would evade the plunge by deflating itself and making a sudden dive beneath the surface of the shallow water, immediately coming up only a few inches away and again participating in the same behaviour. These actions although indulged in by males only did not seem to have the nature of combat, but rather a friendly game of sport. At these times females apparently in the role of spectators, were seen at the edge of the water or higher on the bank of the pool. No observations were made of the mating or egg-laying.

Mr. Clanton found a specimen in a crayfish hole (or burrow of its own making) August 12. It was in a somewhat damp depression in a pasture more than a quarter of a mile from the nearest spawning pond.

O. U. M. 364-371, 866-872, 876, 878-887.

8. Rana catesbeiana Shaw. Common Bullfrog.

The bullfrog was fairly common wherever suitable habitats were available. It was collected as early as February 16. In the spring of 1927 the smaller individuals appeared first, early in March, while

the larger ones were not seen until late March and early April, and were not common until about May 1 when the song of the species was first heard. Adults were found in the larger, more permanent bodies of water although recently transformed young were collected in shallow streams, wet-weather pools and stock ponds.

O. U. M. 372-375, 382-384, 739, 779-785, 820, 821.

9. **Rana pipiens Schreber. Leopard Frog.**

Throughout the spring, summer and autumn this was the most common amphibian of this locality. It was collected as early as February 16, in 1927, and was seen on every night trip taken after that date. During that season the singing of this species became general by March 10 and continued through the months of April and May. The first clasping pairs were collected March 10 and the last, April 9.

O. U. M. 385-387, 736-738, 757-778, 819, 877.

LIZARDS

All the lizards collected by the writer have been examined by Mr. C. E. Burt in his recent study of the lizards of Kansas.*

Since a detailed study of the life history of the Five-lined Skink, Eumeces fasciatus (Linn.), is being made by Leonora K. Gloyd, data of such nature is not given in this paper. It is also thought best to report separately the observations on the life history of the Sonoran Skink, Eumeces obsoletus (Baird & Girard).

1. **Ophisaurus ventralis (Linn.). "Joint-snake"; "Glass-snake".**

This legless lizard was fairly common in this region. It was found occasionally among dead leaves and decaying matter driven by the wind into brush piles and bushes. In June, 1926, one was seen in the open crawling swiftly in short grass. It took refuge in a clump of gooseberry bushes and dead leaves and escaped. Captive specimens were observed to leave their skins entire when moulting. The cast off skins were not turned inside out as with snakes although short sections were often telescoped into each other.

Eight eggs were deposited by a captive female July 22, 1927. They were described by an assistant as similar in color and shape to those of Eumeces fasciatus and slightly smaller. Unfortunately they were not hatched.

Sometimes this species is referred to as "straw-snake" and "hoop-snake". Since the regeneration of a new tail produces a growth quite distinct in color from the rest of the body, which might easily be mistaken for a "horn" by the uninformed in a superficial examination, it is not improbable that the Ophisaurus is responsible for the local belief in the hoop-snake story. O. U. M. 295-300, 913, 926, 972, 973.

2. **Cnemidophorus sexlineatus (Linn.). Six-lined Lizard.**

Although occasionally met with, this was not a common species. A specimen was taken April 27, 1925, in the woods near the bank of the Pottawatomie River between Lane and Greeley. Three adult males were found under flat stones on a hilltop in the Chippewa

*Trans. Acad. Sci. St. Louis, vol. 26, no. 1, 1928.

Hills, eight miles southwest of Ottawa, May 3, 1927. O. U. M. 283, 284, 955-957.

3. Leiolopisma laterale (Say). Ground Lizard.

This little skink was abundant in wooded country near Ottawa. It frequented wooded bluffs, both limestone and standstone, although it seemed to be found in somewhat greater numbers near the latter. Almost every specimen was secured among leaves on or near the ground. A few were dug out of crevices in dead logs or between rocks. A gravid female which died June 9 contained five eggs. Two other females deposited eggs on June 9 and June 27 respectively. The first set numbered four eggs, three of which hatched August 21. At time of hatching the young skinks measurer 40, 44 and 48 mm. in length. There were only two eggs in the second set. When laid their dimensions were 7.8x5.5 mm. and 7.5x5.5 mm. O. U. M. 251-261, 733.

4. Eumeces anthracinus (Baird). Coal Skink.

In Franklin County this species was found in the same habitats as Eumeces fasciatus although much less abundantly. It was taken occasionally in a heavily wooded sandstone region near Homewood in the southwestern part of the county. A female collected May 3, 1926, deposited eight eggs averaging 6x10 mm. in size duringing a period of two days, June 21-23. Six of them hatched July 24 and 25. Of the remaining two, one contained a dead embryo when laid and the other spoiled a few days later. The young skinks averaged 47 mm. in length and were black in color except for blue tipped tails and a reddish tint on the rostral, mental and labial plates. In a few days all fed upon small insects captured with a sweep net. O. U. M. 197-200, 202-206. No. 197 was identified by Dr. Frank N. Blanchard.

5. Eumeces fasciatus (Linn.). Five-lined Skink; Blue-tailed Skink.

This was perhaps the most abundant lizard of the region. Wooded upland country with decaying logs, wind-blown piles of brush and leaves, and loose rocks seemed to offer it most satisfactory habitats. It was more widely distributed than the preceding species, however, having been found in a greater variety of situations, sometimes on the borders of woodlands almost encroaching on the prairie. It was collected as early in the season as April 6 and as late as the middle of September. O. U. M. 207-223.

6. Eumeces obsoletus (Baird & Baird). Sonoran Skink.

This larger skink was found most often under stones in more or less open situations, exposed prairie hillsides or sparsely wooded pasture land. On a few occasions specimens were collected beneath stones imbedded in the earth to a depth of ten or twelve inches.

The act of copulation of this species was observed in the laboratory on April 21, 27, and May 6. Between June 11 and 13, 1925, eleven eggs were deposited in a box containing two females enroute to Michigan. It was not definitely known that these were all laid by the same individual. Because of lack of proper facilities for caring for them on such a journey none were hatched. In 1927 a set of eggs laid by a female secured by Mr. Clanton were hatched August 22. O. U. M. 226-244.

SNAKES

The snakes of the region were studied more carefully than any other group. Only two species reported by Branson (1904) were not collected. One of these, Heterodon nasicus Baird & Girard, the Texas or western hog-nosed snake, is a form associated with dry and sandy regions. Habitats of this sort are very scarce or entirely wanting in Franklin County. Inasmuch as Branson's Franklin County specimen cannot now be found, and since the easternmost Kansas record for this snake known to the writer is Riley County, more than a hundred miles west, it seems probable that Branson's report was an error. The other species, Lampropeltis triangulum triangulum (Lacepede), milk snake, is represented in the Museum of the University of Kansas by but one specimen, number 2253, from Douglas County, which adjoins Franklin on the north. Since this locality is far outside the range of that form as defined by Blanchard (1921) it is probable that the locality given for this specimen is incorrect and this subspecies should not be admitted to the faunal list of the state unless more specimens are discovered.

Notes are given (see tables at end of paper) on the scutellation of the Ottawa University Museum series of each species of snake from this locality. In the cases in which the O. U. M. series is unusually small, additional data is supplied from a few specimens in the collection of the writer (indicated by the letter G preceding the number) or from individuals which were used for exchange. It is hoped that this will give a more useful indication of the variation found in the species of this area. Lack of space makes it impractical to include scale counts of the entire O. U. M. series of Agkistrodon mokasen, Crotalus horridus and a few others. As a matter of reference, however, the museum numbers of all individuals of these series are listed.

The pit vipers, Agkistrodon mokasen, Sistrurus catenatus catenatus, and Crotalus horridus, are not treated in detail in this paper because they are the subjects of special studies being made by the writer.

1. Carphophis amoena vermis (Kennicott). Worm Snake.

The worm snake, a common species in this region, was collected in damp places beneath stones and decaying logs in both wooded and open country. None were seen in the absence of cover. A female (O. U. M. 923) taken April 28 contained four eggs which averaged 15x6 mm. in size. The tough outer egg membrane had not yet been formed and in one egg a germinal disc about 2 mm. in diameter was visible.

In the entire series examined the black dorsal color extends laterally on the third row of scales.

2. Diadophis punctatus arnyi (Kennicott). Ring-necked Snake.

Although this species was taken in relatively large numbers in other localities in eastern Kansas, it was surprisingly uncommon in the Franklin County region. Only five specimens were secured here in three years. These were under stones or logs on hillsides covered with open woods.

3. Heterdon contortrix (Linn). Hog-nosed Snake.

The harmless "blow-viper" or "spreading adder" was found occasionally in eastern Kansas although it was by no means common. Four specimens were secured in Franklin County. Two of these were very dull colored with the pattern very indistinct even just after shedding. The markings of the other two were relatively brilliant. Each was kept alive in the laboratory for several months and all fed occasionally upon frogs and toads. Only one of the four ever went through the performance of "playing dead" and turning belly upward with wide-open mouth. All soon became so accustomed to the presence of human beings that no amount of rough handling could induce them to spread their heads and hiss.

4. Liopeltis vernalis (Harlan). Smooth-scaled Green Snake.

Only one Kansas specimen of this beautiful little snake has been seen by the writer. This was collected in the Chippewa Hills about eight miles southwest of Ottawa, May 22, 1928, by Wilbur Doudna. It was reported from Franklin County by Branson (1904) but the specimen on which this record was based could not be found. This locality is well within the range of the species but apparently it is rare in this region.

The specimen at hand (G 707) is a male. Scale rows 15, ventrals 132, caudals 93, supralabials 7, infralabials 8, oculars 2-2, temporals 1-2, total length 465 mm., tail length 167 mm. Since the color of this specimen in life was different from that of others seen by the writer in the eastern portion of its range, a color description is here given, using the terminology of Ridgway's Color Standards and Color Nomenclature. Top and sides of head above labials forest green; back and upper sides of body and tail light elm green, sides paler on second and third rows of scales, the green color ending abruptly at middle of second row of scales; lower three fifths of rostral white, upper part same as top of head; supralabials white with very slight trace of green on upper borders; infralabials, chin shields and gulars white; lower sides of body (first scale row and lower half of second) pale greenish yellow, yellow extending faintly on outer edges of ventrals and caudals; ventrals and caudals white except for slight edging of yellow laterally; anteriorly ventrals faintly washed with yellow.

5. Opheodrys aestivus (Linn.). Rough-scaled Green Snake.

This species was occasionally taken among bushes and shrubbery a foot or two from the ground. One specimen was resting on a mat of dried leaves beneath a growth of sumac and dogwood, and another was raked up from beneath a bed of closely packed leaves. All that were secured were collected on a wooded rocky hillside at "Gould's Ford" on Middle Creek, seven miles southeast of Ottawa. Some that were kept alive for a time fed readily on grasshopper nymphs and crickets. On one occasion a small individual was swallowed by a larger one, presumably as the result of an attempt on the part of both to eat the same insect. Since the smaller snake was regurgitated later, it is probable that this was not an indication of cannibalistic tendencies on the part of this species.

6. Coluber constrictor flaviventris (Say). Blue Racer.

One of the most abundant snakes of this region was the blue racer. It was collected as early in the season as April 1 and one was seen basking on a sunny ledge on December 15. In this locality the coloration of this species is greenish gray, olivaceous or greenish blue above with underparts ranging from pale creamy white to light yellow. Individuals up to 650 mm. in length were found retaining some of the juvenile spotting.

It proved very unsatisfactory as a captive as all specimens kept alive consistently refused to eat small birds, mammals, frogs, toads, insects and earthworms.* On two occasions smaller snakes of the same species were eaten and the stomach of a small individual received from George W. Saip contained a very young "glass snake", Ophisaurus ventralis.

A male and female blue racer (O. U. M. 910 and 911) were found together under a stone April 4, 1927. There were not in the act of mating but this circumstance suggests the probability that they were sexually mature individuals although both showed traces of the juvenile coloration. A larger pair (1077 and 1223 mm. in length) were collected together May 12.

While walking through a growth of rather thick underbrush, sumac, scrub oaks, and tall grass one day in midsummer (July 22), the writer was startled by a zipping buzz among the dead leaves some ten feet to the left. The sound at once suggested a rattlesnake. Upon carefully looking the ground over in that direction, a very large blue racer was distinguished among the leaves and debris. Perceiving that it was observed it plunged over the edge of a nearby ravine with tremendous speed. Had it remained quiet it would have been passed unnoticed. The habit of vibrating the tail when annoyed or disturbed has been noted many times in captive individuals of this species. This incident, however, is the only occasion in the writer's experience in which it has been known to occur in the field. O. U. M. specimens not listed in the table are numbers 55-61, 120, 121, 507-510.

7. Elaphe laeta (Baird & Girard). Rat Snake.

Rocky hills with sunny slopes and sparse woodland growth represent the type of habitat in which this species was most frequently collected. It can not be considered of common occurrence in this locality. On a few occasions it was found under stones in company with blue racers and copperheads. As it was never seen abroad in daytime it is probable that it is more nocturnal in its habits than its relative, the pilot blacksnake, Elaphe obsoleta obsoleta. Living specimens fed upon white-footed mice (Peromyscus sp.), house mice, white rats, white mice, and English sparrows.

No adult females were taken and nothing was learned about its breeding habits or life history. A small specimen (O. U. M. 1053) taken in October is probably a young of the year.

*Captive blue racers in the writer's laboratory have recently fed upon house mice which were seized quickly and killed by being pressed down under the coils of the snake's body. In the instances observed the snakes did not coil about their prey.

8. Elaphe obsoleta obsoleta (Say). Pilot Black Snake.

The common "blacksnake" of this region was more or less abundant in wooded areas throughout the spring and summer. It was frequently seen among the branches of trees at heights from ten to thirty feet, basking in the sun on top of piles of brush, or stretched in graceful curves on the ground. Its movements were usually sluggish although it traveled quite rapidly when it desired. Eight specimens preparing to hibernate in a well in company with two blue racers, Coluber constrictor flaviventris, and a small bull snake, Pituophis sayi, were taken November 12, 1926. They were resting in the crevices of the rocks less than twelve feet below the surface of the ground. The well was carefully walled up and closed at the top, making the method of entrance of the snakes a matter of conjecture.

A three-foot specimen was seen in the field tightly coiled about a baby cottontail rabbit. Another when captured contained three unbroken bird eggs which it was caused to regurgitate. The eggs were entirely white and judging from their color, shape and size, probably those of the bob white.

As a rule this species was easily fed in captivity since most individuals would readily take mice, rats and sparrows either dead or alive. In different snakes, however, considerable variation in feeding habits was observed, some eating whenever the opportunity was offered and others refusing all food. One large male lived seven months without eating although food such as was eaten by others of the same species was frequently supplied. Individual temperment also varied markedly. Some were consistently nervous and cross and would not submit to being handled without struggling and biting; others were extremely gentle and would climb about one's arms and shoulders without manifestation of nervousness.

Several years before the writer began a serious study of snakes, a pair of six-foot pilot blacksnakes was kept for a few months in a laboratory cage. Just before the last of May, upon visiting the cage one night with a flashlight, the pair was seen in copulation. The act was repeated the following night and on several occasions the male was observed to attempt a renewal of such relationship but was repulsed by the female. Fourteen eggs were deposited July 30. The largest measured 56x24 mm.; the smallest 45x24 mm. A well developed living embryo was found in one egg August 17, but due to improper conditions of moisture none of them hatched. Another female deposited a set of nine eggs July 11, 1927. These were cared for by Mr. Clanton and all hatched August 22. Two of these are O. U. M. 1051 and 1052.

Newly hatched specimens had a light grayish-tan ground color and from 30 to 35 dark brown dorsal spots on the body. A series of smaller dark brown lateral spots alternated on each side with the dorsal spots. Such specimens were between 300 and 400 mm. in length. These may be confused with the young of the rat snake, Elaphe laeta, but can be distinguished by their smaller number of dorsal spots which are elongated longitudinally. E. laeta has 40 to 57 dorsal spots, transversely elongated. Several young specimens

all less than 400 mm. long were collected between May 3 and 13, 1925 and 1926. These were thought to have been hatched the preceding fall. One of these, two days after its capture, regurgitated the partially digested remains of a small white-footed mouse, Peromyscus sp. Many individuals between three and four feet in length still showed an easily distinguishable color pattern, and it could be traced in several that were considerably larger, especially just after shedding.

9. Pituophis sayi (Schlegel). Bull Snake.

This large prairie-frequenting species, common throughout most of the state, is one of the few snakes which many farmers are beginning to recognize as an ally in the struggle against injurious rodents. The potentiality of the bull snake as a rodent destroyer has been shown by work done at the Kansas State Agricultural College and Experiment Station (Hisaw and Gloyd, 1926). Although captive specimens fed occasionally upon birds and eggs, a decided preference in favor of pocket gophers, rats, mice, rabbits and ground squirrels seemed to be indicated.

Various authors state that individuals of this species attain a length of nine feet but it is not likely that any of such size have been found since the prairie regions have become more thickly settled. The largest measured by the writer had a length of 2095 mm. (6 ft. 10 1-2 in.).

A set of twelve eggs was discovered in the field August 30. They were partially imbedded in soft earth under a stone. A large female deposited two eggs July 7 but died before the remainder of the set were laid. Dissection revealed sixteen additional eggs. Another female deposited a set of ten eggs July 11. A third female collected June 16 deposited sixteen eggs July 4. They were uniform white in color, roughly elliptical in shape, and averaged 52x38 mm. in size. The egg having the greatest length measured 57x39 mm.; the shortest egg 48x38 mm.; that having the greatest diameter 56x42 mm.; that having the least diameter 53x36 mm. It can be seen from this that the shape varied considerably; the longest egg not necessarily the largest in total mass, and the shortest not necessarily the smallest. The tough leathery outer coverings adhered closely to one another holding the entire mass together with the exception of one egg which appeared to have been the last deposited.

This set of eggs was placed in a box of moist decaying wood and kept slightly damp by sprinkling with water every three or four days. They increased in size slightly during the next four or five weeks and then began to shrink and become discolored. One was opened and examined September 13, seventy-one days after the eggs were deposited. It contained a well-developed, living and very active embryo 384 mm. long. Considerable yolk was yet unabsorbed. On one side of the egg membrane where a rot or mould had eaten almost through, a gelatinous blister-like growth had formed on the inside, reinforcing the weak spot.

Six young emerged September 18, seventy-six days after the eggs were laid. The remaining eggs, with the exception of three in which the embryo died, hatched the two succeeding days, September 19 and

20. Little gashes, one-half to three-fourths of an inch long, were cut in the membranes by the "egg teeth" of the baby snakes. Each egg bore more than one cut. Sometimes the second and third were almost parallel to the first and sometimes they extended in several directions. Noses and heads protruded from the egg membranes several hours before the young snakes completely emerged. When the heads were extended even slightly any stimulus heard or felt by the little snakes caused them to be retracted.

Two days after hatching the thirteen young snakes were weighed and measured.

	5 males	8 females	13 both sexes
Average weight	33.41 gm.	31.06 gm.	31.9 gm.
Average length	424.00 mm.	412.50 mm	416.mm.

All were very nervous and vicious and would hiss and strike at the slightest provocation. At the average age of ten days the skins were shed for the first time. One took food first at the age of nine weeks when it succeeded in swallowing a very small baby rat. Three others took food of a similar nature a few days later. Eleven individuals of this brood are represented by O. U. M. numbers 740-750.

10. Lampropeltis calligaster (Harlan).
Yellow-bellied King Snake; Blotched King Snake.

This was the only king snake common in this locality. It was found under rocks both in open woods and on exposed hillsides. Some were taken in pastures where the short grass offered little cover, some in gardens and lawns and others crossing roads between fields. Although usually seen during the day, two were captured at night when crossing the road in the light from an automobile.

In about two dozen specimens collected in this vicinity the darker coloration predominated. Very dark individuals showing the striped effect pointed out by Blanchard (1921, pp. 118-119, fig. 40) were common. The belly coloration was usually white with small, indefinitely shaped grayish spots. Only a few had the ground color washed with a light salmon-orange tint, more intense along the midline.

Laboratory feeding experiments showed that this king snake is somewhat partial to a diet of mice. Both house mice and white-footed mice were eaten without hesitation by the majority of captive specimens. On two occasions English sparrows were eaten, one being swallowed tail first. Once a large calligaster made an attempt to swallow another of the same species. The smaller snake escaped by struggling vigorously although three attempts upon its life were made. Young white rats were consistenly refused although on one occasion one was seized and killed. Mr. Wesley Clanton in the summer of 1927 fed this species on lizards, Eumeces fasciatus and Eumeces obsoletus. No evidence was obtained in confirmation of Branson's statement (1904, pp. 396-397) that cold blooded prey, such as frogs and fish, are eaten.

The yellow-bellied king snake was usually quite gentle and tractable in its behavior toward man. It seldom became angry enough to use its teeth when being handled. When this occured, however, it

seized the hand or wrist and chewed vigorously. Its power of constriction was shown quite strikingly when a small specimen less than two feet long killed by means of its body coils a large brown rat (Rattus norvegicus) which had been placed in the cage to be eaten by some larger snakes.

No eggs of this species were obtained. Four newly hatched young (O. U. M. 423-426) which seemed to be no more than two or three days old, judging from the condition of the egg membranes from which they had emerged, were received from a farmer August 21 without any data as to where or when they were discovered. Three were females and one a male. Their lengths in millimeters were as follows: 273, 269, 275, and 280.

11. **Lampropeltis getulus holbrooki (Stejneger).**
Speckled King Snake.

The "salt and pepper snake", as this king snake is sometimes called, was fairly common although less often seen than Lampropeltis calligaster, as it appeared to be more secretive in its habits. It was collected beneath stones, fallen trees and under piles of decaying bark. One large and handsome specimen was dug out of the ground by the writer's father while spading in his garden.

Most speciments were black finely spotted with bright yellow above, the size of the spots varying slightly with different individuals. In practically all specimens examined groups of yellow spots were arranged to form more or less distinct transverse bars at regular intervals.

This species showed more aggressiveness in its feeding habits and more tendencies toward cannibalism than any other snake studied. Those kept alive fed upon mice, dead or alive, English sparrows, lizards (Eumeces fasciatus) and other snakes. One, when placed temporarily in a cage with other species, promptly seized a Lampropeltis getulus boylii and almost killed it before attention was brought to the performance. Another ate a Lampropeltis calligaster nearly as large as itself, another killed and swallowed a Lampropeltis triangulum syspila, and still another fed upon its own species. A specimen directly from the field had eaten five or more bird eggs resembling those of the bob white. Toward man these snakes seemed very friendly. They struggled very little when captured and could be handled carelessly without their becoming angry or alarmed.

A female in the museum laboratory deposited ten eggs June 22 sometime before 1:00 p. m. When first noticed five had become white and opaque but the remaining five were still soft and translucent. Upon further contact with air they gradually became like the others. Their average length was 37 mm. and average diameter 18 mm. Five soon shriveled and no development could be detected when their contents were examined. The embryos of three others were dead ten days later. Two weeks after deposition the remaining two had decreased in length and increased in diameter and one showed a decided swelling on one side. A slit about 7 mm. long was

noticed on one egg August 24. This opening was lengthened the following day and two days later a very active liittle snake emerged. It caused its tail to vibrate energetically whenever approached. In appearance it was unusually "plump" because of the large amount of unassimilated yolk. Two days after hatching it shed its skin. The other egg was cut August 27 and hatched the following day. Both individuals were males; lengths 270 and 202 mm.; the tail lengths 38 and 30 mm.

12. Lampropeltis triangulum syspila (Cope). Red Milk Snake.

This king snake appeared to be rare in this vicinity. Only six specimens were secured. All were collected under stones in open woods. One was beneath a deeply imbedded sandstone rock, eight inches below the surface of the ground. It was extremely nervous and vicous, setting its tail in vibration whenever anyone came near and often attempted to bite when handled. It fed twice upon lizards. Eumeces fasciatus and Leiolopisma laterale, but escaped from the building before its scales were recorded. Others in captivity ate lizards of the species mentioned and one swallowed a small water snake, Natrix grahamii. During the summer of 1927 a small specimen of Mr. Clanton's fed several times upon baby mice, small five-lined skinks, Eumeces fasciatus, and worm snakes, Carphophis amoena vermis. Another of Mr. Clanton's specimens collected May 29 deposited six eggs July 3. They averaged 35x10 mm. in size and were not hatched.

13. Natrix grahamii (Baird & Girard). Graham's Water Snake.

This species occurred about creeks, ponds and sloughs. Its behaviour was gentle and inoffensive, even timid. Captives fed greedily upon small fish and frogs. Several were collected at night April 9, and on this occasion three were seen tightly rolled up in a bell-like mass although it was not determined whether or not they were mating.

14. Natrix rhombifera (Hallowell). Diamond-backed Water Snake.

Small lakes, marshes and ponds, rather than streams were the habitats which this large, vicious water snake most often frequented. Most individuals struggled fiercely when captured and were always ready to use their long teeth if given a chance. After being near people in the museum for a few days they submitted to being handled carefully although they permitted no liberties. They fed voraciously upon fish, frogs and frog tadpoles, but always refused warm-blooded animals. Dead fishes and frogs were eaten with no hesitation. If only one frog were available the snake which seized it first would often be set upon by all the others in the cage and a general melee would follow. After the frog was swallowed each snake would move rapidly about the cage searching in every corner, all of them quivering with excitement.

Late in the afternoon of May 6 three or four medium-sized N. rhombifera, two of which when captured proved to be males, were seen in close contact with a much larger individual which was doubtless a

female. Since they were encountered suddenly there was no time for the observer to conceal himself and the snakes quickly took alarm. The female escaped. It is probable that the males were attempting to copulate with the female. Mr. Clanton saw a pair in coitu May 15.

A gravid female which died from injuries received when captured was brought to the museum July 29. Dissection showed the presence of twenty-five eggs, most of which contained living embryos. Eleven were in the left oviduct and fourteen in the right. Another female (O. U. M. 1023) collected July 13, 1927, and kept by Mr. Clanton, gave birth to 34 young Nvoember 8. Fifteen of these are O. U. M. numbers 1024 to 1039.

Chin shield tubercles, which are considered a secondary sexual characteristic, were present on all males examined except O. U. M. 440.

15. Natrix sipedon sipedon (Linn.). Common Water Snake.

No other water snake was as abundant in the Franklin County region as this species. It occurred commonly about creeks, rivers and small ponds and was less often seen in marshes or swampy places. Its demeanor was less agressive than that of the diamond-backed water snake although in captivity many of its habits were similar. It fed upon fishes, frogs and tadpoles and was as greedy as N. rhombifera in regard to appetite. It also refused to be interested in warm-blooded animals as food.

This species was seen mating May 15 and a large female dissected August 25 contained thirty-six young which probably would have been born within a few days siince practically all of the yolk in each egg was absorbed. Of this number 19 were in the left oviduct and 17 in the right.

16. Natrix sipedon transversa (Hallowell). Blotched Water Snake.

This form was less common than the preceeding and its habitats were somewhat different. While occasionally taken in the streams it was in most cases found in marsh and swamp land and on several occasions individuals were discovered in upland habitats. One was sunning itself on a pile of brush in a woodlot several hundred yards from water. In captivity its food habits were similar to those of Natrix sipedon sipedon.

17. Storeria dekayi (Holbrook). DeKay's Snake.

Specimens of this small inconspicuous reptile were taken among leaves, under stones, and in decaying logs in open woods. Two were found in the near proximity of water. Rarely were individuals seen crawling in the open. Those kept alive fed regularly on earthworms and slugs but did not eat small insects, ant larvae and spiders. Sometimes the little snakes would not eat unless an end of an earthworm was placed between their jaws with a pair of forceps. Once started the worm was eagerly swallowed, some of the smaller specimens eating worms closely approaching their own lengths.

18. Storeria occipito-maculata (Storer). Red-bellied Snake.

Both color phases of this interesting little snake were found in Franklin County. The majority of the specimens secured were dark bluish slate or blackish plumbeous above with two dark dorsal lines. Each dark line was made more prominent by the presence of a row of fine, closely placed white spots along the side nearest the mid-line. Another row of similar white spots was laterally placed between the first and second scale rows. About one-third of the total number of specimens taken were of a cinnamon-brown color above with the longitudinal striping very indistinct. The scutellation was similar in all cases and the undersides were uniformly red. Occipital spots were present in all, but less dintinct in the brown individuals.

This species was most common in the sandstone woods of the south-western part of the county and was found under rotten logs, among leaves and under boards. Two of the brown phase were basking in the sun on the smooth brown clay of a dry stream bed. A bluish gray specimen was captured while crossing an open space on a large bed of Polytrichum and Usnea.

In the laboratory few of these snakes were persuaded to feed. Some occasionally ate earthworms.

A gravid female collected May 1 died July 24. It contained seven embryos, three in the left oviduct nearest the cloaca and four in the right oviduct anterior to these.

19. Virginia valeriae elegans (Kennicott). Ground Snake.

Only two specimens of this species were taken. Both of these were collected May 9, 1926, in the heavily timbered sandstone woods near the village of Homewood. They were secured by raking through thick piles of dead leaves. They lived for several weeks in the laboratory and each fed upon earthworms. In both specimens the following scale data is the same: scale rows 17, supralabials 6, infralabials 6, oculars 0-2, temporals 1-2. O. U. M. 465, male, has 123 ventrals, 43 caudals, total length 231, tail length 48. The color was uniform light brown above and lighter below. No dorsal spots were present. O. U. M. 466, female, has 132 ventrals, 34 caudals, total length 224, tail length 33. In color it was like number 465 except that it had four longitudinal series of small dark spots, one series at each side of the midline and the others lower down at about the fourth row of scales.

The taking of these two individuals extends the known range of this species some distance to the northwest of the localities from which specimens were examined by Blanchard in his recent revision of this genus (1923).

20. Tropidoclonion lineatum (Hallowell). Line Snake.

More of these little snakes were taken in the fall than in the spring. One was found in the blue grass of the college campus, another was taken while crossing a sidewalk, and others were concealed beneath stones, boards and debris. One was discovered in a crevice of a

wooden post about ten inches below the surface of the ground February 25.

Very little was learned about the habits of this shy and gentle species. Those studied alive ate earthworms, some taking them eagerly and often. A newly born dead Tropidoclonion was found in one of the boxes July 25, 1926. It was the aborted offspring of a female (O. U. M. 467) collected November 5, 1925. It measured 82 mm. in length and its tail length was 11 mm. This seems to indicate that mating in this species sometimes occurs in the fall as no males occupied the same box after the month in which this specimen was collected.

21. **Thamnophis sauritus proximus (Say). Western Ribbon Snake.** In early spring the ribbon snake was common about ponds and marshes although not as abundant as Thamnophis sirtalis parietalis. About a dozen were collected at night April 9 in a marshy pond a few hundred yards from the Marais des Cygnes River. They were resting on the tops of bushes and weeds just above the surface of the water and feeding upon the small frogs (Pseudacris triseriata and Hyla versicolor) which were to be found everywhere in the pond. When approached with the acetylene headlight they made no effort to escape but submitted to being picked up gently and placed in the collecting bags. In the laboratory they seemed always hungry and ate small fish, frogs and tadpoles.

A gravid female (O. U. M. 474) was collected July 23 under a stone in open pasture land among sparse growths of sumac, coralberry and mullen. Four days later eight young were born. They averaged 238 mm. in length, the largest measuring 248 and the smallest 227 mm.

22. **Thamnophis radix radix (Baird & Girard). Plains Garter Snake.** This species was common in town about dooryards, gardens and parks, as well as in the country where it was taken in woods and pastures, under stones on wooded hillsides, and in almost every habitat suitable for snakes. The food eaten by captive specimens was similar to that of the ribbon snake although many individuals were somewhat more timid about taking fish or frogs from the forceps or one's fingers.

Only one gravid female was kept until her young were born. This specimen was collected June 2. Thirteen young were born August 6; two were dead when discovered and one of these was still coiled within the foetal membranes. At the age of six days the remaining eleven averaged 187 mm. in length.

23. **Thamnophis sirtalis parietalis (Say). Red-barred Garter Snake.** In habitat preference this form appeared to be similar to the plains garter snake, Thamnophis radix radix, although it was seen more often in the lowlands. On several occasions it was taken near ponds and small streams. One was collected at night while swimming across an open space between the sedges in a small marsh.

Captives of the red-barred garter snake did not feed as readily as other species. Some took frogs, small fish and tadpoles but others showed no disposition to eat.

A female collected July 22 gave birth to fourteen young August 8. Of these the last two or three to be born appeared between 8:00 and 9:00 a. m. Four were dead when discovered. The ten which lived at the age of five days averaged 193 mm. in length, extremes in size being 185 and 203 mm.

24. Agkistrodon mokasen (Beauvois). Copperhead.

Copperheads were found on rocky hillsides in several localities in Franklin County but by far the most abundantly in the wooded hills on Middle Creek near Gould's Ford, seven miles southeast of Ottawa. Here the rocky bluffs were unsuited for pasture and little frequented by human beings. Deep crevices furnished ideal hibernating quarters and the ledges made suitable places for basking in the sun. In early spring when snakes were just coming out of hibernation, a search beneath the loose slabs of rock along these ledges was always fruitful. Twenty-eight copperheads were collected in this area the afternoon of April 30, 1926, in a little more than three hours time. Gravid females were secured during the latter part of August in 1925, 1926 and 1927.

A form of the white-footed mouse, Peromyscus sp., was found here in some numbers and is thought to form a considerable item in the food of these snakes. One accidentally killed in the field had eaten several soft bodied Cicadas which had just transformed from the nymph stage. Captive copperheads ate small white rats, white mice, house mice, small brown rats, white-footed mice and English sparrows. None showed the slightest interest in fish or frogs.

Twenty-seven Franklin County specimens of the copperhead are preserved in the O. U. M. collection. In addition to those listed in the table of scale data, O. U. M. numbers for this species are 48-50, 518, 519, 521-523, 525-529, 531-534, 1014, 1015.

25. Sistrurus catenatus catenatus (Rafinesque). Massasauga; Pigmy Rattlesnake.

Three specimens of this small rattlesnake were secured. A small idividual believed to be a young of the year was found in a potato field September 11, 1925. It escaped from the laboratory before it was measured. The other two were taken in a meadow May 30 and June 9, 1926, respectively. In each case attention was attracted to the snake by the barking of a small dog. Both of these snakes fed on house mice and white-footed mice and one ate a very small cottontail rabbit. Another specimen in the O. U. Museum collection (No. 75) was taken in 1888.

26. Crotalus horridus (Linn.). Timber Rattlesnake; Banded Rattlesnake.

The timber rattlesnake was almost abundant in the Gould's Ford region mentioned in the account of the copperhead. These two spe-

cies were very intimately associated. On several occasions they were found together under the same protecting rocks. One flat stone three feet in diameter sheltered three rattlesnakes, four copperheads, and two blue racers. At the same time the twenty-eight copperheads were collected, April 30, 1926, twenty-three rattlesnakes were secured. In April and May, 1925, five specimens were taken in this locality; in 1926, thirty-two; in 1927, six; and April 23, 1928, the writer visited the place again and secured eight. Eight were taken in October, 1926, and three in the same month of 1927.

No one place formed the "den" of these snakes. They were scattered along two wooded hillsides, each with a southern exposure, although a few were encountered on the north sides of these same hills. They became scarce each year after the middle of May when they moved out into the fields and lowlands. Local residents reported killing several in fields and along hedge rows during the summer months. Toward the last of September and up to the middle of October they were found in the rocks again.

This rattlesnake was extremely gentle in captivity and even in the field its mild demeanor was noticeable. The writer stepped directly over the largest specimen taken in this region while it was coiled on a sunny spot in a path to the top of the bluff. It made neither sound nor movement and was not discovered until a few moments later. When captured it struggled fiercely. In the museum some individuals fed more regularly and eagerly than others. White rats, white mice, house mice, white-footed mice, baby cottontail rabbits and English sparrows were eaten.

Franklin County specimens in the O. U. M. collection not listed in scale data table are numbers 71, 72, 551, 552, 556, 558-561.

TURTLES

Because of the lack of proper facilities no special effort was made to collect turtles. Neither were detailed life history studies attempted.

1. Chelydra serpentina (Linn.). Snapping Turtle.

In ponds, creeks and marshes and in the Marais des Cygnes River the snapping turtle was collected on several occasions. An eight-inch specimen was found partially covered with mud in the bottom of a small pasture creek February 17. Small individuals were brought to the museum on numerous dates throughout the spring and summer. They fed on crayfish and scrap meat.

A medium-sized female began laying eggs July 22 and deposited fifteen between that date and August 3. The following table shows the relation between the number of eggs and the days when they were laid.

Date	number of eggs laid
July 22	1
25	1
26	1
27	1
28	2
29	4
30	1
31	3
August 3	1
Number of days 12	Total eggs 15

The eggs were not quite spherical. They averaged 28.1x28.4 mm. in diameter. Only two hatched. The young turtles, with a dull yellow bulb of yolk still outside the body and attached to the middle of the posterior half of the plastron, emerged October 7. O. U. M. 92, 97-99, 115-117.

2. Terrapene ornata (Agassiz). Western Box Turtle.

Aside from numerous individuals seen along the highways this species occurred in considerable abundance in pastures, meadows and open woods. Several were found in burrows in the ground, some under stones and one beneath a rotten log.

A captive pair was observed mating May 11 and another May 12. In an inclosure in which between two and three dozen box turtles were kept, four eggs were discovered July 30. They had been crushed by the movements of the crowded animals. All females were removed and kept separate for a few weeks. Only one produced eggs, perhaps the same one which laid the original four. The first egg definitely known to be from this female was deposited August 2. Another was laid August 3 and a third the following day. They were elongate-elliptical in shape with much thinner shells than those of Chelydra serpentina. Their measurements follow: 36x24 mm., 37x22 mm., 36x23 mm. O. U. M. 104-107, 756, 1048, 1049.

3. Graptemys geographica (Le Sueur). Map Turtle.

Dr. W. B. Wilson collected a large individual of this species at Half-circle Lake between Ottawa and Pomona March 11, 1926. A smaller specimen was taken by the writer in the Marais des Cygnes River near Ottawa September 21, 1926. These specimens were identified by Dr. Frank N. Blanchard. O. U. M. 76, 873.

4. Chrysemys marginata bellii (Gray). Bell's Turtle.

Bell's turtle was the most common water turtle of the region. It was collected or seen in marshy ponds, creeks and rivers on numerous occasions. Some that were kept in a tank in the museum fed on crayfish and small pieces of meat. O. U. M. 80, 84, 85, 91, 108-110.

5. Pseudemys elegans (Wied). Red-eared Turtle; Cumberland Terrapin.

Two specimens of this form were taken by Mr. Clanton. They were secured in a small branch of Middle Creek in the southeastern part of the county June 13, 1926, and May 14, 1927, respectively. O. U. M. 113, 1047.

6. Amyda spinifera (Le Sueur). Spiny Soft-shelled Turtle.

While it was reported that soft-shelled turtles occur frequently in the streams of this region only one came to the notice of the writer while at Ottawa University. This specimen was taken in the same locality as the Pseudemys elegans above mentioned, June 13, 1926. It was kept alive for several weeks and fed often on crayfish and scraps of meat. Two other representatives of this species collected several years previously are in the O. U. M. collection. O. U. M. 81, 82, 114.

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Explanation of Tables

In the following tables the number of longitudinal scale rows of each specimen is taken in three places; a short distance posterior to the head, near the middle of the body, and just anterior to the anal region; e. g., 21-19-17. The total number of ventrals (gastrosteges), caudals (urosteges), and labials is given in each case. The number of preoculars is followed by a number of postoculars; e. g. 1-2. Temporals of the first and secnd (or third) rows are indicated by two (or three) numbers; e. g., 1-3 (or 2-3-4). Whenever two figures are given for labials, or two series of figures for oculars or temporals, the first refers to the left side of the head. A single number, or series, indicates that both sides are the same. Whenever the figures for certain characters are the same in each specimen in the series, they are given in condensed form immediately following the table for each species. All meausurements are given in millimeters. A plus sign after the number of caudals or measurements of length indicates that a part of the tail has been lost.

TABLES OF SCALE DATA ON SNAKES

1. Carphophis amoena vermis Kennicott).

O.U.M. No.	Date	Sex	Ventrals	Caudals	Infralabials	Temporals	Total length	Tail
64	April '23	♂	137	36	5	1-1:1-2	200	32
129	'24	♀	139	27	6	1-2	145	16
135	May 11, '24	♂	129	36	6	1-2	265	48
136	May 11, '24	♀	145	27	5	1-1	135	15
388	May 16, '26	♀	143	27	6	1-1	301	36
389	July 10,'26	♀	143	27	6	1-1,1-2	159	20
390	Sept.21,'26	♂	137	35	6	1-2	139	23
923	April 28,'27	♀	141	29	6	1-2	314	42
Scale rows 13, supralabials 5, oculars 0-1.								

2. Diadophis punctatus arnyi (Kennicott).

O.U.M. No.	Date	Sex	Ventrals	Caudals	Total length	Tail
---	May 17, '25	♀	167	43	360	57
---	Apr. 18,'26	♀	172	39	406	58
921	Apr. 28,'27	♂	157	48	161	32
---	Apr. 29,'27	♂	152	45	291	58
922	Apr. 29,'27	♂	152	44	275	53
Scale rows 17-15; supralabials 7, infralabials 8, oculars 2-2, temporals 1-1						

3. Heterodon contortrix (Linn.).

O.U.M. No.	Date	Sex	Ventrals	Caudals	Supralabials	Oculars	Temporals	Total length	Tail
53	Sept.10, '25	♂	130	45+	8-9	10†	3-4	761+	142+
---	May 16, '26	♂	131	51	8	11	4-4	697	132
---	Apr. 28, '27	♂	132	52	8	12-11	4-4	667	140

Scale rows 25-19; infralabials 10.

† In this species pre- and postoculars are not differentiated; a series of small scales encircle the eye beneath the supraocular.

4. Liopeltis vernalis (Harlan). (See discussion of this species in text.)

5. Opheodrys aestivus (Linn.).

O.U.M. No.	Date	Sex	Ventrals	Caudals	Infralabials	Oculars	Total length	Tail
11	Aug. 9,'21	♂	160	111+	8	1-2	733+	253+
G 6	Sept.13,'25	♀	155	98+	7	1-2	361+	110+
---	Apr. 26,'26	♂	158	125	8	1-2	450	168
---	Oct. 30,'26	♀	160	121	6-7	1-2	229	80
G 70	Apr. 27,'27	♀	157	115	8	1-2	558	193
G 71	Apr. 28,'27	♂	159	121	8-7	1-2	537	196
G 72	Apr. 28,'27	♂	158	119	8	2-2	564	205
Scale rows 17-15; supralabials 7, temporals 1-2.								

6. Coluber constrictor flaviventris (Say).

O.U.M. No.	Date	Sex	Ventrals	Caudals	Supralabials	Infralabials	Oculars	Temporals	Total length	Tail
402	Apr.17,'26	♂	171	89	6-7	7	2-2	2-2-2	1004	262
403	Apr.17,'26	♂	175	90	7	7-8	2-2	2-2-2	867	218
404	Apr.17,'26	♂	173	90	8	8	2-2	{2-2-4 / 3-3-3}	817	204
405	Sept. '26	♂	172	83	7	8	1-2	2-2-2	1027	238
910	Apr. 4,'27	♀	175	72	7	8	1-2	2-3-2	600	131
911	Apr. 4,'27	♂	179	83	7	8	1-2	1-2-2	651	160
Scale rows 17-15.										

7. Elaphe laeta (Baird & Girard).

O.U.M. No.	Date	Sex	Scale rows	Vent-rals	Caud-als	Infra-labials	Temp-orals	Total length	Tail
G 9	Sept.16,'25	♂	25-27-19	223	62	11	1-2-3	975	145
----	Apr. 10,'27	♂	25-27-19	212	27+	12	{2-2-4 / 2-1-3}	1115+	95+
----	June 22,'27	♂	25-27-19	215	50+	12	{2-[illegible]-[illegible] / 2-[illegible]-4}	975+	42+
----	Aug. 30,'27	♂	26-27-19	215	67	11	{2-3 / 2-4}	745	125
----	Apr. 10,'27	♂	26-27-19	212	70	12-13	2-2-4	1200	210
1045	May 21,'27	♂	27-27-20	211	27+	12-11	{2-2-4 / 2-3-4}	1130+	90+
1046	July 23,'27	♂	26-27-19	215	50+	12-13	{2-2-3 / 2-3-4}	1020+	132+
1053	Oct. 8,'27	♀	25-27-20	219	63	11	{2-3-4 / 2-4-4}	328	52

Supralabials 8; oculars 1-2.

8. Elaphe obsoleta obsoleta (Say).

O.U.M. No.	Date	Sex	Scale rows	Vent-rals	Caud-als	Supra-labials	Infra-labials	Temp-orals	Total length	Tail
406	Aug.22,'25	♂	25-27-19	235	90	8	12	3-3-5	1588	263
407	Apr.17,'26	♂	29-28-20	229	71+	8	12	irreg.	1395+	235+
408	Apr.17,'26	♂	25-29-19	224	65	9-8	13	{2-3-4 / 2-3-6}	1095	181
410	Nov.12,'26	♀	29-27-19	230	78	8	13	{2-3-3 / 2-3-4}	1370	222
411	Nov.12,'26	♂	28-27-19	234	83	8	13	2-2-4	1509	265
412	Nov.12,'26	♀	29-27-19	231	74	8	13-12	{2-4-5 / 2-3-5}	1380	230
413	Nov.12,'26	♂	25-25-19	225	79	8	13-12	{2-3-3 / 2-3-4}	1538	275
414	Nov.12,'26	♀	28-27-19	229	72	8	11-12	{2-3-4 / 2-2-4}	1380	204
415	Nov.12,'26	♀	28-27-19	230	72	8-9	13	irreg.	1300	203
1051	Aug.22,'27	♀	27-27-19	237	82	8	12-11	2-2-4	283	48
1052	Aug.22,'27	♂	26-27-21	228	79	8	12	{2-4-5 / 2-4-4}	366	62

Oculars 1-2.

9. Pituophis sayi (Schlegel).

O.U.M. No.	Date	Sex	Scale rows	Vent-rals	Caud-als	Supra-labials	Infra-labials	Oculars	Total length	Tail
420	Apr. 29,'26	♂	27-32-22	225	50+	9	15	1-4	1662+	174+
1010	Sept.12,'27	♂	28-31-24	231	59	9	12	2-3;2-4	1148	140
1011	Aug. 15,'27	♀	31-33-24	236	57	9	13	2-4;2-3	1560	195
----	May 3,'27	♂	31-35-25	228	57	9	12	2-4	2095	242
G162	May 9,'27	♂	30-31-23	220	55	9	12	2-3;2-4	1440	180
G163	July ,'27	♂	29-32-24	223	58	8	12	1-3	1550	190

Temporals very irregular.

10. Lampropeltis calligaster (Harlan).

O.U.M. No.	Date	Sex	Scale rows	Vent-rals	Caud-als	Supra-labials	Infra-labials	Temp-orals	Total length	Tail
37	May 14,'22	♂	25-25-19	204	54	7	9	2-3-4	901	128
38	June 16,'22	♀	24-25-19	208	47	7	10	2-2-3	891	109
39	Sept. 9,'23	♂	25-25-19	208	51	7	9	2-3-4	824	109
67	Sept. '25	♀	23-25-19	209	45	7	9	2-3	803	105
68	Sept. '25	♀	24-25-19	208	47	7	10	2-3	657	89
422	June 11,'26	♀	25-25-19	206	43	8-7	9	2-3-4	1007	119
427	Sept.20,'26	♀	25-25-21	208	46+	7	9	2-3-4	990+	122+
428	Sept.22,'26	♂	26-25-19	203	39+	7	9	2-3-4	1055+	115+
971	May 1,'27	♀	25-25-19	203	48	7	9	2-3-4	421	53

Oculars 1-2.

11. Lampropeltis getulus holbrooki (Stejneger).

O.U.M. No.	Date	Sex	Scale rows	Vent-rals	Caud-als	Infra-labials	Ocul-ars	Temp-orals	Total length	Tail
45	May 14,'22	♂	21-21-19	212	49	9	1-2	2-3-4	297	39
46	May '25	♀	21-21-19	208	42	9-10	1-2	2-3-3 2-2-3	887	92
430	Aug.26,'26	♂	21-21-19	209	47	9	1-2	2-3-4	216	29
431	Aug.26,'26	♂	20-21-19	208	47	9	1-1	2-3	254	34
432	Sept. '26	♂	21-21-19	217	47+	10	1-2	2-3-4	1070+	135+
433	Oct. 1,'26	♂	21-21-19	212	47	9	1-2	2-3-4	1120	128

Supralabials 7.

12. Lampropeltis triangulum syspila (Cope).

O.U.M. No.	Date	Sex	Scale rows	Vent-rals	Caud-als	Supra-labials	Infra-labials	Temp-orals	Total length	Tail
G 17	May 14,'22	♂	?-21-19-17	203	47	7	9-8	2-3-4	673	88
----	May 3,'27	♂	19-21-19-17	204	49	7	9	2-3-4 1-2-3	258	39
964	May 12,'27	♂	?- ?-19-17	201	46	6-7	9	2-3-4	705	98
----	May 29,'27	♀	21-21-19-19	207	43	7	9	1-2-3	604	75
1054	June '28	♀	21-21-19-17	204	42	7	9	2-3-4	695	75

Oculars 1-2.

13. Natrix grahamii (Baird & Girard).

O.U.M. No.	Date	Sex	Scale rows	Vent-rals	Caud-als	Infra-labials	Ocul-ars	Temp-orals	Total length	Tail
12	May 14,'22	♀	19-17	165	57	10	2-2	1-2-2	513	89
G 7	Oct.30,'24	♂	19-17	175	67	9	2-2	1-2	237	48
G 8	Nov.26,'24	♂	19-17	173	65	10	2-2	1-2-2	525	103
435	May 14,'26	♀	19-17	165	55	10-11	2-3 2-2	1-2-3 1-2-2	231	44
---	May 14,'26	♀	21-19-17	162	57	10	2-2	1-(2)-3	789	125
---	May 14,'26	♂	19-19-17	173	63	10-9	2-2	1-2-2 1-1-2	675	118
919	Apr. 9,'27	♂	20-19-17	172	67	9	2-2	1-2-3	530	100
920	Apr. 9,'27	♀	21-19-17	155	54	8-9	2-2	1-3-3 1-2-3	635	108

Supralabials 7.

14. Natrix rhombifera (Hallowell).

O.U.M. No.	Date	Sex	Scale rows	Vent-rals	Caud-als	Infra-labials	Ocul-ars	Temp-orals	Total length	Tail
436	Apr. '26	♀	24-23-21	142	59	11	2-3,1-3	1-2-3	1110	232
437	May 16,'26	♂	25-25-21	140	71	11	1-3	1-2-2	835	216
438	May 29,'26	♀	26-26-21	139	60	11	1-3	1-3	1052	225
439	May 29,'26	♀	27-27-21	138	50+	10	1-3	1-2-1	785+	145+
440	May 29,'26	♂	25-23-20	141	69	11	1-3	1-2-1	673	164

Supralabials 8.

15. Natrix sipedon sipedon (Linn.)

O.U.M. No.	Date	Sex	Scale rows	Vent-rals	Caud-als	Oculars	Temporals	Total length	Tail
170	May 14,'26	♂	22-23-17	139	74	1-2	1-3	403	102
446	May 14,'26	♀	23-23-18	147	58	1-3;2-3	1-3	792	162
447	May 22,'26	♀	23-25-18	137	67	1-2	1-3	796	165
448	Aug.17,'26	♂	23-23-19	138	76	1-2;1-3	1-3	423	110
449	May 22,'26	♀	24-23-19	141	65	1-3	1-3	228	53
450	May 22,'26	♂	22-23-17	142	76	2-3	1-2-4	257	68
451	May 22,'26	♂	22-23-17	141	78	1-3	1-2-4	295	78
452	May 22,'26	♀	23-23-19	142	65	1-2	1-3	245	58

Supralabials 8, infralabials 10 in all except No. 449,
No. 449, supralabials 9; infralabials 12-11.

16. Natrix sipedon transversa (Hallowell).

O.U.M. No.	Date	Sex	Scale rows	Ventrals	Caudals	Infralabials	Oculars	Temporals	Total length	Tail
453	Oct. 3,'25	♂	23-22-17	151	76	10	1-3	1-3	769	185
454	Apr.20,'26	♀	23-25-19	153	64+	10-11	1-2;1-3	{1-3-3 / 1-3-4}	1335+	250+
455	May 6,'26	♀	23-22-18	149	70.	10	1-3	{1-3-5 / 1-2-5}	1048	233
456	May 13,'26	♂	23-23-18	147	83	10	1-3	1-3-4	804	200
457	May 12,'26	♂	23-23-17	150	80	10-9	1-3	{1-2-5 / 1-2-3}	724	180
458	May 17,'26	♀	23-23-19	151	30+	10	1-3	1-2,1-3	865+	120+

Supralabials 8.

17. Storeria dekayi (Holbrook).

O.U.M. No.	Date	Sex	Ventrals	Caudals	Supralabials	Infralabials	Oculars	Temporals	Total length	Tail
G 5	Nov. 4,'22	im.	122	56	6-7	6-7	2-2;1-3	1-1	108	27
459	Oct. '25	♀	129	45	6	6	1-2	1-3	280	53
460	Apr.15,'26	♂	122	68	7	6	1-2	1-2	192	45
461	Apr.29,'26	♂	129	53	6	6	1-2	1-3	293	67
924	Apr.27,'27	♂	127	57	7	7	1-2	1-2;1-3	197	48

Scale rows 17.

18. Storeria occipito-maculata (Storer).

O.U.M. No.	Date	Sex	Ventrals	Caudals	Oculars	Temporals	Total length	Tail
9	May 3,'25	♀	125	45	2-2	1-1	234	48
10	May 3,'25	♀	126	47	2-2	1-1	215	46
462	May 9,'26	♀	123	8+	2-2	1-2	187+	9+
463	May 9,'26	♀	131	48	2-2	1-2	238	51
464	May 16,'26	♂	121	55	2-1	{1-2-2 / 1-1-2}	262	69
---	May 23,'26	♂	120	51	2-2	1-2	221	55

Scale rows 15; supralabials 6; infralabials 7, unnumbered specimen, brown phase.

19. Virginia valeriae elegans (Kennicott). (See discussion of this species in text.)

20. Tropidoclonion lineatum (Hallowell).

O.U.M. No.	Date	Sex	Scale rows	Ventrals	Caudals	Supralabials	Temporals	Total length	Tail
1	Feb. 2,'25	♂	17-19-15	151	39	6	2-3	268	41
27	Oct.21,'25	♀	17-19-17	141	33	6	1-3-3	327	41
467	Nov. 5,'25	♀	17-19-17	141	32	5	2-2,1-3	358	42
468	Nov.11,'25	im.	17-19-17	141	36	5-6	2-2-3	147	20
469	Oct.27,'26	♂	17-17-15	140	43	5-6	1-3	150	26
470	Nov. 7,'26	♂	17-17-15	137	41	6	2-2-3	147	25
471	Nov.15,'26	♂	17-17-15	143	38	6	1-2-2	152	23

Infralabials 6; oculars 1-2.

21. Thamnophis sauritus proximus (Say).

O.U.M. No.	Date	Sex	Ventrals	Caudals	Supralabials	Infralabials	Temporals	Total length	Tail
472	Apr. 18,'26	♂	169	50+	9-8	10	1-3	504+	95+
473	May 22,'26	♀	169	94	8	10-9	1-2-3	383	106
474	July 23,'26	♀	169	95	8	10	1-2-2	602	167
475	July '26	♀	166	86	8	10	1-2-3	545	150
485	June 6,'26	♀	164	96	8	10	1-2-2 / 1-2-3	654	176
914	Apr. 9,'27	♀	165	97	8	10	1-2-2	722	202
915	Apr. 9,'27	♀	169	25+	8	10	1-2-3	670+	68+
916	Apr. 9,'27	♂	156	36+	8	10	1-2-3	505+	72+
917	Apr. 9,'27	♀	160	94	8	10	1-2-2	745	206

Scale rows 19-17; oculars 1-3.

22. Thamnophis radix radix (Baird & Girard).

O.U.M. No.	Date	Sex	Scale rows	Ventrals	Caudals	Supralabials	Infralabials	Total length	Tail
486	May 4,'26	♀	19-21-19-17	154	57	8	10	488	97
487	May 13,'26	♀	19-21-19-17	149	69	7-8	9	658	144
491	Nov.26,'26	♀	21-19-17	152	74	8-7	9	317	78
912	Apr.19,'27	♂	19-21-19-17	161	78	8-6	10-9	552	126
1013	May 23,'27	♀	19-21-19-17	150	71	7	10-9	474	114
G646	May 21,'28	♂	19-19-19-17	154	66	7	10	545	125
G647	May 21,'28	♀	21-19-17	154	67	8-7	10	545	103
G648	June 4,'28	♀	19-21-19-17	150	28+	7	10	630+	75+

Oculars 1-3, temporals 1-2-3.

nophis sirtalis parietalis (Say).

O.U.M. No.	Date	Sex	Scale rows	Ventrals	Caudals	Temporals	Total length	Tail
30	June 30,'21	♀	19-17	154	74	1-2-3	459	114
---	Oct. 29,'24	♂	19-17	157	79	1-2	523	138
497	Aug. 14,'26	♀	21-19-17	153	81	{1-3-3 / 1-2-3}	613	164
498	Aug. 13,'26	♀	21-19-17	152	75	1-2-3	695	168
499	Aug. 21,'26	♂	21-19-17	153	37+	1-2-3	427+	64+
918	Apr. 9,'27	♂	19-17	163	89	1-2,1-3	560	148

Supralabials 7, infralabials 10; oculars 1-3.

24. Agkistrodon mokasen Beauvois.

O.U.M. No.	Date	Sex	Scale rows	Ventrals	Caudale	Supralabials	Infralabials	Oculars	Total length	Tail
513	Aug.22,'25	♀	23-21	149	32-11*	8	10	2-4	570	73
514	Aug.22,'25	♀	23-19	149	33-13	8	10	2-4	620	78
515	May 7,'26	♂	24-23-20	145	32-14	7	10	2-4	628	97
516	May 7,'26	♂	24-23-19	146	34-15	7-8	9	2-4	603	87
517	May 7,'26	♀	25-24-20	142	31-13	?	11-10	2-5	469	65
520	Apr.30,'26	♂	24-23-19	143	26-20	8	10-9	2-5	447	62
524	Apr.30,'26	♂	25-23-19	146	27-18	8	10	2-4	492	76
530	Apr.30,'26	♂	27-23-20	148	24-23	8	10	2-4	662	95
1014	June 3,'27	♀	28-23-19	150	24-19	8	9	2-4	393	52
1015	June 3,'27	♂	26-23-21	147	30-16	8	9-10	2-3	728	97

*In this species the caudals toward the tip of the tail are divided.

25. Sistrurus catenatus catenatus (Rafinesque).

O.U.M. No.	Date	Sex	Scale rows	Ventrals	Caudals	Supralabials	Infralabials	Total length	Tail
75	1888	♂	30-27-20	153	26	12	13	580	52
537	May 30,'26	♂	25-27-20	145	29	11	14	656	77
538	June 9,'26	♂	24-23-18	145	33	12	13	713	87

Oculars 2-4.

26. Crotalus horridus (Linn.

O.U.M. No.	Date	Sex	Scale rows	Ventrals	Caudals	Supralabials	Infralabials	Total length	Tail
51	May 13,'25	♂	27-23-19	174	24	14	15	1150	81
553	Apr.30,'26	♂	26-22-19	171	26	14	16	576	47
554	Apr.30,'26	♀	24-23-19	175	21	14-13	16-15	732	51
555	Apr.30,'26	♀	26-23-19	174	18	14-15	15-16	714	45
557	Apr.30,'26	♀	24-23-19	172	19	14-15	15	631	43
562	Apr.30,'26	♂	26-23-19	167	23	13-14	15	725	60
563	Apr.30,'26	♂	26-23-19	170	23	15-13	14-15	775	61
564	Apr.30,'26	♂	26-23-19	172	25	14	15	853	74

Oculars 2-5.

Continued Archaeological Studies in the Navajo Country, Arizona*

ALBERT B REAGAN, PH D

*The reports now published are "Archaeological Notes on Pine River Valley, Colorado, and the Kayenta-Tuba Region, Arizona" Trans Kan Acad Sci., Vol. 30, pages 244-331, 1922, and "Archaeology of the Tuba-Kayenta Region." ibid, pages 394-437

The present paper includes the following six papers (reports) which have been cut down to the single article with the above title "Notes on the Navajo Country, Arizona (1923)," "Notes on the Navajo Country, Arizona, (a continuation of the 1919, 1921 and 1922 reports), (1924);" "Archaeology of the Cornfields District, Arizona (1925)," Archaeology of the Cornfields-Hopi Volcanic Buttes' Field. (1926);" "Notes on the Cornfields Region, Arizona, (a continuation of the 1925 Report (1927);" and "Notes on the Archaeology of the Cornfields Region, Arizona, (a continuation of the 1927 Report) (1928)"

(Professor J V Cortelyou of the Kansas State Agricultural College greatly aided the Publication Committee by editing a large portion of this paper before it was read by the committee.—Publication Committee)

This work was in two fields—a continuation of the study of the ruins about Kaventa, Arizona, and a study of the ruins in the Ganado-Cornfields district 120 miles a little east of south of Kayenta. The findings at Kayenta are considered first, followed by those in the Ganado-Cornfields section.

CONCLUDING REPORT ON THE ARCHAEOLOGY OF THE TUBA-KAYENTA REGION

(Continued from 1919 and 1920)

Ruins up the Kaykota Creek

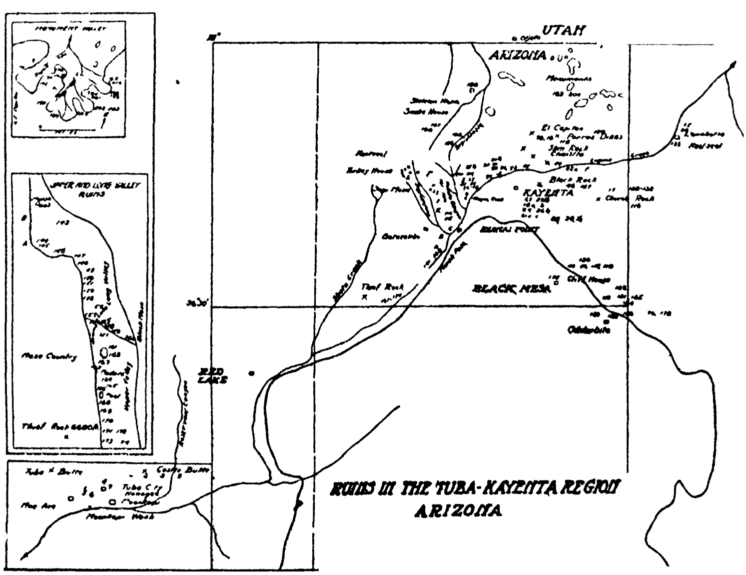
As you will find by former reports Kaykota creek (there given as Kaykohte creek) leads out northward from Laguna creek just west of the reclamation dam west of Moqui Rock three miles west of Kayenta. Many ruins and burial places along this creek were described in those reports (pages 397-403 loc. cit.). The ruins here described are additional findings, as follows:

Ruin 200 (continuation of the numbering of the ruins from former reports, except that this number should have been 205 instead of 200.) This ruin is about a mile northeast of Ruin 102 (Wind Cave) of my previous reports. It is a cave on the east side of the canyon. Only two rooms now show. There were more rooms, but time has leveled them . The place has been a sheep corral for many years and is accessible by horse.

No. 201. This village is high up in a cave now inaccessible, except by ladders. It was not entered by the writer. A retaining wall along the face is still intact and some four feet in height. In the rear is a small wasp-shaped, cone-built room placed against the wall. It had a small door on its front, probably 2 1-2 feet by 2 feet. The cave faces south. The village probably had 40 inhabitants. Between the retaining wall and the rear room there is much debris, which seems to be three or more feet thick.

The Segi-ot-sosie trail leads out of the canyon in which this ruin is situated. Near the head of the canyon there are three caves. None of them show any signs of having had buildings in them. Pottery, scanty in quantity, was found near each.

MAP I



RUINS IN THE TUBA-KAYENTA REGION, ARIZONA

No. 202. This is a double ruin in a canyon which faces the east. It consists of a base village and a gallery. The base village was large and has the appearance of having had two periods of occupancy, the later village having been built on the former. One building partly intact shows in an east-and-west line. It was rectangular in

shape. Two kivas also show. The one is a six pillared kiva, having shipapu hole, fire-place box, and a ventilator. The other kiva was probably of the same style. A part of its west wall was the original canyon wall. Several other buildings show in part-foundation. Much excavation work has been done here by parties whose identity is unknown to the writer. It is quite probable that 300 people lived in this village and the gallery.

Some 80 feet above the base there is a shelf that contains two intact segments of a village, one small room and a long building facing east with a southeast-facing-south large end room. This last segment contains several rooms and is two stories high with the chamber-floor rafters still in place and with ends sticking through the outside walls. The gallery is now wholly inaccessible except by a long ladder or by ropes from the top of the cliff.

The 6-pillared kiva connects this ruin with the Mesaverde ruins and the ruin just around the corner east of Keet Seel ruin (Turkey House). This would seem to indicate that they were probably all made by the same people.

No. 203. This ruin is on the west side of the west fork of the east canyon of Kaykato creek one-half mile south of Ruin 202 and one miile west of Ruin 201. It is in a cave whose "bow-string" is about 100 feet long. Two rooms still remain intact, but roofless. One is round, the other rectangular. There is also much debris about the site, and part-foundations of rooms show now and then. Probably 40 people once lived there.

No. 204. This is village debris that shows in the open at the forks of the canyon below the above ruins and undobtedly indicates the site of an open-air village. No idea of its size could be conjectured.

Ruins 205-207. While collecting school children, during a light rain, the writer saw three ruins of villages in the open. Time and weather would not permit the examination of any of them.

No. 205. This ruin is in the flat about three miles due east of Porras Dikes to the north of Comb Ridge. Its size was not estimated. Near it the Navajos now farm quite extensively from wash-overflows in rainy spells, and probably these same fields raised the crops of the villagers.

No. 206. On the north side of Laguna creek about the upstanding remnants of a volcanic dike south of Comb Ridge some 2 miles north of Church Rock much broken pottery was observed.

No. 207. On a high flat at the head (north end) of a north-and-south gorge in Comb Ridge, about a mile east of Porras Dikes, there has been a large village. It was built partly in an east-and-west direction in parallel rows, one of the north rows still showing a considerable pile of rock, as does a south tier. The debris covers a large area. The water supply for this village was from seepage in the rock walls of the gorge and in small finger-like canyons coming into it from the south, and probably also from Laguna creek valley adjacent. The farm lands were also in the Laguna creek valley and probably in the flats north of Comb Ridge where the Navajos now

farm, as is mentioned under, 205. Probably 300 people lived in this village.

No. 208. A ruin site was observed across the wash about two miles northeast of Porras Dikes. It was strewn with much very-finely, broken pottery and a few stones that probably were used in fireplaces. The village was small and was probably circular or D-shaped.

No. 209. A village site, strewn with pottery and in appearance very similar to Ruin 208 above, was seen in the Laguna creek valley north of the creek about four miles east of Church Rock.

No. 210. A ruin was seen west of a wash about three miles northeast of Thief Rock. It was on a sand ridge west of the valley leading towards Tuba, near some Indian cornfields. It is represented now principally by scattered pottery. Its size could not be estimated, but it seems to have been large.

Nos. 210 and 211. Two ruins, similar to the last above, were seen north of a wash one mile northwest of the well that is about 4 miles northwest of Chilchinbito. They were each probably large villages.

Nos. 212-214. The remains of three ruins show in the sand dune area north and adjacent to Summit lake. Nothing but broken pottery and a few scattered rock now show on each site. The villages were all small.

No. 215. A ruin was seen about a mile west of the Chilchinbito store. It was west of the first valley west of the store, abbutting the west rocky wall. The main part seemed to have been circular, 24 paces in diameter. The site is now a mound, strewn with much broken pottery and some building rock. Beyond it to the northeast and east there are quite a number of sherds scattered here and there for quite a distance. This seems to indicate that the village extended there also in detached segments.

No. 216. On the east wall of the same valley about a mile west of Ruin 215 in a canyon leading northwest there once was a series of rooms along a lodge in the Dakota sandstone wall. One cone-shaped room still remains practically intact, with the exception of the southwest wall. It was about 5 feet in diameter at the base and less than 5 feet high. It was probably used as a store bin. The other rooms were also very small. These rooms can be seen from Chilchinbito trail that mounts Black Mesa southwest of Chilchinbito.

No. 217. An east and west rectangular mound some 30 paces by 13 paces in area was seen about two miles east of Chilchinbito. It is on a little knoll just south of the Chilchinbito-Rough-Rock road. Some wall-foundations still show in place and considerable pottery is scattered about the site. Only a few people had lived in this place.

Another set of striking Kayenta ruins is in the headwaters of the Segi group of canyons above the ruins of Betatakin and Keetseel of my former reports, as follows:

Scaffold House was so named because it possesses a finely made, wooden scaffold which the ancients constructed in a vertical cleft in the cliff about fifty feet above the east end of the ruin. The village is 300 feet long and contains fifty-six dwelling rooms and two circular religious buildings.

Cradle House is a large ruin in the side of a bluff rising above East Canyon. It is so named from the finding of a cradle in perfect preservation in one of the rooms. It contains fifty dwelling rooms and three circular edifices used for purposes of worship.

Ladder House is a more or less dilapidated village to be seen from the left bank of East Canyon, a few miles further up-stream from Cradle House, so named because an ancient ladder was found still in place. It is a picturesque ruin on one side of a projecting butte that reminds one of an elephant's trunk in shape.

Forest-Glen House is situated about two miles above Ladder House, shut in on the valley side by a fine growth of trees. Some of its walls are in the form of concentric semicircles, with the conspicuous represention of a head attached to one side.

Pine-Tree House is eight miles up East Canyon and was so named because a large pine tree is growing on the edge of the cliff above it. It is a very conspicuous ruin of large size.

Trickling-Spring House is several miles up a side canyon to the right of Laguna Creek, some miles above Marsh Pass. The entrance to this cliff ruin is surronded and more or less concealed by stately pines, spruces, and cedars, near a trickling spring.

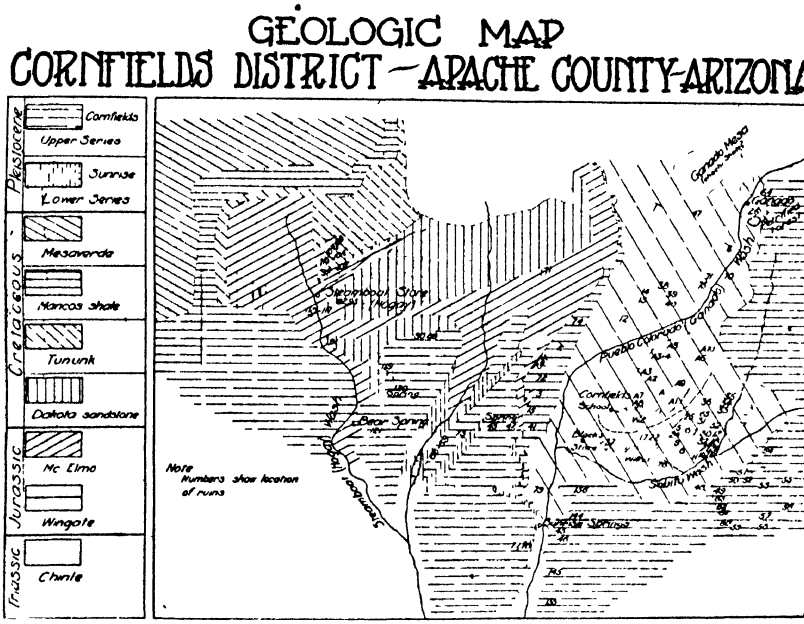
ARCHAEOLOGY OF THE CORNFIELDS-GANADO REGION, ARIZONA, (With Map II), 1923 Report.

The Cornfields-Ganado region in the Navajo country, as here considered, lies 45 miles about due west of Fort Defiance, Arizona, and about 64 miles northeast of Holbrook on the Atchison, Topeka and Santa Fe Railroad in the same state. It covers the middle course of Pueblo Colorado (or Ganado) wash and its tributaries. It extends from below Sunrise Springs and the Hopi Buttes to several miles above Ganado post office on the wash, and westward from it to Steamboat on Steamboat canyon eighteen miles and on to Salina twenty-eight miles still further to the westward, and southward a distance of twenty miles.

It is a much dissected region. The valleys and canyons, however, are not deep, but are wide-floored instead; and Pueblo Colorado wash is still building its flood plain in most of the section. Moreover, for the most part, the region is a Tertiary-rock country where the streams have not removed that formation in comparatively recent times. The other predominating rocks are those of the Triassic, Jurassic, and Cretaceous eras.

The white settlements in the region are as follows: Steamboat trading store in Steamboat canyon, Salina trading store at Salina, Klegotoh trading store at Klegotoh, and Wide Ruin trading store at Wide Ruin. The other settlements and trading places are all on Pueblo Colorado wash.

MAP II.



GEOLOGICAL MAP OF THE CORNFIELDS-GANADO DISTRICT

(Scale: 35 mm equals 1 mile.)

(Note: "Pleistocene" should be "Tertiary-Pleistocene.")

Sunrise Springs is on the wash near the south terminus of the region under consideration, and like Steamboat, it consists of a trading store only. Cornfields is in the middle section. It has Maxwell Black's trading store and post office, and the government school and stockman's station at Cornfields. Ganado on the same wash at the northeast end of the section is somewhat scattered. It is composed of the Roman Hubbell trading store, summer resort and post office, the Presbyterian Mission boarding school of Ganado, the Carrigan trading store, and the reclamation plant and headquarters two miles above the post office. Cross-Canyon, also mentioned, is eleven miles southeast of Ganado.

The natives of the region are Navajos, and seem to be quite prosperous for Navajos. They farm quite extensively both within the reach of the water of the irrigation plant and below it in the Cornfields-Sunrise Springs area. They have fine flocks of sheep and goats. The women make many blankets each year.

The conspicuous landmarks are Ganado mesa north of Ganado, and the white-gray tufa-bluff, mesa-wall with underlying white McElmo overtowering Pueblo Colorado wash west of Cornfields, the latter being so white that it looks like giant snowbanks in the moonlight.

The region as a whole is on the Ganado side of the DeChelly upwarp where monoclinal folds are exposed, the most conspicuous one being the Ganado monocline in the vicinity of Ganado itself. Passing

northward-northwestward this upwarp passes into the Tusayan downwarp near Steamboat wash (canyon) where the Cretaceous and Jurassic (?) rocks emerge from beneath the Tertiary which covers them in the Ganado wash area and the country southward toward Wide Ruins.

The region seems not to have been visited by white men until after our government got possession of the state. The scientific exploring party of Newberry (Ives) (1) passed through Ganado and Steamboat in 1857-1858, the Newberry (Malcomb) party in 1859, (2) and that of Howell in 1872-1873. (3). No other scientific people seem to have visited the section till in recent years.

Only two subjects relating to this region have ever been touched—geology and archaeology. The geology was reported by Dr. Herbert E. Gregory of the United States Geological Survey, by whom the following papers have been published: "Geology of the Navajo Country;" (4) "Water Supply Paper on the Navajo Country;" (5). "The Black Mesa Coal Field of Arizona;" (6). and "Garnett Deposits in the Navajo Reservation in Arizona and Utah." (7). The only person who has done archaeological work in the vicinity, so far as the writer can learn, and his work was southeast of the section under consideration, was Dr. J. Walter Fewkes, his publication being "Two Summer's Work in Pueblo Ruins". (8). For a complete bibliography of the publications bearing on the archaeology of the Navajo country in general, the reader is referred to the bibliography in the publications: "Archaeolobical Explorations in Northeastern Arizona" by Kidder and Guernsey, pages 221 to 223, (9), and that in "Basket Maker Caves of Northeastern Arizona" by the same authors, pages 119-121. (10).

The writer wishes to thank the government stockman, Paul E. Gradall, and Maxwell Black, the post-trader at Cornfields, for their kindness in aiding him in locating the ruins of the region.

Human Habitation

When the white man came to the region he found the Navajo-Apache in possession, but before the coming of the Athapascans at least two other races made it their abode, each for a considerable period of time. Both of these were village-house people; the rock structure, as we have seen, is such that there were no cliffs or caves suitable for village use in the region. On the other hand, the limestone conglomerate of the Chinle formation and the tufa-sandstone and lime rocks of the Tertiary, as has been noted, were durable enough for the construction of "great houses" of a durable nature, though time has now leveled them or reduced them to a heap of stone. The principal ruins of the region, therefore, are in the area covered by these two formations, and the Dakota rocks in the vicinity of Steamboat.

The more ancient race had rectangular villages, apparently with cylindrical kivas, judging from the depressions that now show. The other race built small circular and D-shaped villages and circular towers, finished their work in the region by constructing the huge

houses of both the circular (Kintiel and Hogay) and rectangular type (Ruin A). They dismantled the ruins of the former people and used the rocks to construct their villages. They also constructed villages on the ruins of former pueblos, as for instance, Ruin A and the Tower Ruin, opposite Sunrise Springs. In the character and decoration of pottery and the shape of villages, the former belongs to the Tusayan group of village peoples, and the latter to the Zunian division.

The only ruins so far examined in an approximate vicinity are Kintiel (or Wide Ruin) and Kinna Zinde, twenty-five miles southwestward. A bare mention is made of the ruin at Hubbell's store at Ganado and of a circular ruin at 18-Mile spring, six miles west of Steamboat. This account is by J. Walter Fewkes. (8 pp 124-134).

The Ruins Examined

Below is a description of the ruins examined in the region, the ruins being apparently Zunian unless otherwise stated. They are represented by numbers on Map II in the order they were examined.

The Ruin—A Group of Ruins

The Ruins. A group of ruins is situated on a triangular Mesa which is capped with limestone conglomerate on the upper series of the Chinle formation. This triangular area lies east of the Cornfields Indian School with its longest point extending to the school itself. Its northwest and longest limb faces Pueblo Colorado wash. Its southwest limb faces a wash and narrow valley, and its east limb is closed in by overlying Tertiary deposits. The wash southwest of the mesa also swings around to the southeast of it. It has only a narrow valley and is itself not long so that the water it carries in rainy spells is negligible, except for the irrigating of about 20 acres along its valley. The northwest limb faces Colorado wash, as we have seen, and along its edge are most of the ruins of the triangle. One of these is Ruin A, the largest ruin yet seen in the region The Valley of Colorado wash adjacent is 2 miles wide and is of such width for miles. In addition the stream is building here and consequently not canyoned-up at all in the valley fillings—the stream runs on a level with the valley fillings, so that irrigation was easy then, as it now is. Moreover, the underground water reaches to the surface, often a well 6 feet in depth furnishing an abundance of water. Furthermore, the soil of this building valley is probably about as good as that of the valley of the Nile. The only drawback then as now was the cool cliimate due to altitude—6250 or more feet above sea level.

The ruins indicate, as everywhere in the region, that the small house-villages were built first and that as a last stand against enemies the large communal house was constructed last, being added to piece by piece as clans came there for refuge.

Ruin A (or Cornfields Ruin). This is a large rectangular ruin about two miles east of the school. It is laid off approximately east and west. It is 30 paces wide by about 400 paces long. It has two well-defined large plazas and several smaller ones, and six de-

pressions probably representing kivas. It also shows by its make-up that it was added to piece by piece There are also several outlying buildings, now rock mounds, which probably represented watch towers or armed stations. The ruin, as a whole, was built of a poor grade of conglomerate limestone that was quarried one-eighth mile to the westward. The conglomerate limestone here is not as durable as the conglomerate limestone exposed nearer Ganado. The fallen piles are now 6 to 8 feet high in places, the whole village making an impressive mound. The house-space was a row of narrow houses, and the rooms as far as can be made out were small. This ruin was apparently built on a more ancient one that extended much farther eastward.

While there are indications that this site was occupied for a long period of time, the pottery sherds are not numerous. Most of the pottery is of the black and white design-type, though red ware and even yellow show now and then. Some of the designs are like Kayenta ware. The lightning designs are like the Cochiti lightning designs of our day. The other designs favor the Zunian type. Between 600 and 1200 people must have lived in this village

No. A-1. This ruin is on the mesa-bench about a half-mile southwest by south of Ruin A. It was built partly of rock and partly of adobe. A part of the village has been removed by the cutting back of the mesa front. Its westernmost section is a low rocky ridge, 40 feet long, running in an east and west direction. Running southwest along the face of the mesa for several hundred yards there are the remains of what were apparently houses or house rows, now represented by scattered rock and sherds. South of the first ridge of ruins some 108 paces there is an east-west low ridge of rock and adobe 100 yards in length about which there are numerous scattered pottery fragments. Two low spots occur to the west of this ridge and probably represent kiva sites of that far-off time. The size of the village and its population cannot now be determined.

Running east for several hundred yards from this ruin there are what appears to be remains of ancient houses in more or less detached order, representing adobe and stone dwellings. Also extending on southwest by south around a point of sand there are more rooms and village debris. It was at this point where the shifting of the sand exposed the skeletons that we found the dog buried with the human dead under the village debris.

The whole village appears to be much older than Ruin A.

No. A-2. This is a low mound of adobe in which there is considerable scattered rock and many sherds. It is 225 yards east of Ruin A and extends 80 paces in an east-west direction. Its exact size can not now be determined. It, too, is older than Ruin A.

No. A-3. This ruin is 256 paces a little north by east of Ruin 2-A. The village was circular and was 112 paces in circumference Its north buildings were built of stone and represent quite a mound 60 feet in length; the rest was evidently of adobe or sandrock, which has weathered and blown away leaving a low mound and a ring of

pottery and sherds. But little pottery shows about the stone mound. A shallow depression now occupies the center of the plaza and probably represents a kiva. The writer would judge that this ruin also is older than Ruin A.

Quite a bit of debris extends eastward from this ruin for 200 yards, representing additions or rooms, or more probably an older village in which 150 people must have lived.

No. A-4. This is a low, decomposed rocky ridge of limestone 86 paces north of Ruin A-3. It is 42 feet long and seems to represent several house rooms. The decomposed condition of the limestone shows it to be very old, probably older than any of the other ruins in the immediate vicinity.

No. A-5. One hundred eighty-six paces east of Ruin A-3 is a ruin of some size. It is now a massive pile of limestone rubbish 4 feet high by 4 paces wide and 33 paces in length. North of the main row there is a detached circular mound of stone 4 paces across, which probably represents a kiva or an outdoor oven. Also extending southeast from the northwest end of the main heap there extends a wing 14 paces long. Rooms show in the main heap, represented by depressions. A coyote digging after a prairie dog has exposed a north-south wall. No pottery shows in or about the wall-mound, but it is scattered in quantity to the south of what was probably a plaza formed by the main building and its wing. The ruin appears to be of the same age as Ruin A.

No. A-6. This is a building mound of stone 200 yards east of Ruin A-5 and runs east and west It is 18 paces long. More than half of the foundation walls show and there are just 2 paces between the walls on the two sides of the building, making very narrow rooms. A ring of pottery to the south of this stone mound indicates that the village was D-shaped.*

*The loop of the D-shaped ruins is composed of the refuse heap, camp site, ash heap, and burial mound at times, the straight side of the D is the stone village part.

Between this village and No. A-5 around a little draw there are scattered mounds and rock debris, among which there are occasional foundation walls and much broken pottery. It appears to represent a very old village, probably belonging to the Ruin A-6 series. If the whole site was occupied at once more than 100 people must have lived there.

In the flat about one-half mile west of No. A-6 there is some scattered pottery, probably the remains of a one-roomed house or a grave. A few stones also mark the site.

No. A-7. About one-half mile south of Ruin A there is a long east and west mound which shows some stone and considerable pottery fragments. The village is very ancient, probably Tusayan, and was built of adobe, or was built so long ago that the limestone of its walls have mostly disintegrated. Probably 100 people lived on this site.

No. A-8. This is a mound that runs east and west on a low ridge in the valley north of and at the "foot-hills" of the ridge that leads

eastward from the school. It was a large village and was probably built mostly of adobe, as but little rock shows about the mound. Many shards show, especially about prairie dog diggings around the site. The village is apparently very old.

No. A-9. This is a very old ruin at the top of the bench three-fourth of a mile southeast of Ruin A. It is in three or more segments. Each segment has had the north-northwest "graet-house" of rock, the rest of the village apparently being of adobe. The stone village, built of limestone, is so old that it is nearly disintegrated. Much pottery marks the site. Probably 300 people lived in this village.

No. A-10. This is a massive ruin one and one-half miles northeast of Ruin A, topping a rise just southeast of the government telegraph line a mile southeast of Pueblo Colorado wash and one and one-half miles south of No. 40. It was built in sections. It is D-shaped with possible later additions. The straight side of the village is a line of rock, 35 feet of which is now 8 feet high. The addition marked "a" does not show much rock in construction or in the mound, but shows much pottery. Its rock pile is highest at "x", being there less than two feet high. This section may be older than the rest of the edifice. The addition (b) shows that it was added to the main village, and though less in height than the main stone pile it was made apparently wholly of stone, several series of rooms showing now in this extension. The wing of the main village marked (c) was built of stone and is now a massive pile of rock, scarcely less in height than the main straight side of the D. Two kiva depressions show. An isolated small pile of rock also shows without the inclosure, probably representing an oven.

This compact village had about 200 inhabitants.

Other Ruins in Pueblo Colorado Wash Valley

No. 1. Four miles north of the school on the edge of the branch east of Pueblo Colorado wash is the remains of a large village rimming the bench. At its north end there had been a large room constructed of stone and a similar but circular room built of smaller stone at the south end of the edifice. The latter though of kiva-shape seems to have been too small for a kiva, being probably a watch tower or an outside oven The larger building was probably a kiva, though its shape can not now be ascertained. The rocks from which these two buildings were made is a bastard conglomerate limestone which was carried to the site from the valley below where a ledge containing it is exposed. No other buildings now show. The site is covered scatteringly with pottery fragments for a distance of 400 yards in a north and south direction and 50 yards in an east and west direction. It was a large village but judging from the small amount of pottery fragments on the site, it was not inhabited long.

No. 2 On a ridge which runs north of east of the school a line of pottery fragments extend for a distance of more than 500 yards, at some places covering quite a wide extent, at others, narrowing al-

most to the vanishing point. No room foundations now show. Whether it represents one or more villages of different periods of time can not now be determined. The pottery is only scattering, which seems to indicate that the village was not occupied long or that erosion has washed most of the fragments away.

No. 3. This is a small ruin near the Tertiary-McElmo mesa about west of the school.

No. 4. This ruin is 3 1-4 miles northeast of the school. It probably belongs to the Tusayan group.

No. 5. This ruin is on a mesa-bench one mile east of the school. It is Zunian in type.

No. 6. This ruin is 400 yards southwest of No. 5. It shows several walls and rooms in cross-section of the stone ellipitcal mound.

No. 7. This ruin is 100 yards north of No. 6. It is composed of bastard conglomerate limestone and also has a mound of rock near it. There is considerable broken pottery about it.

No. 8. This ruin is 400 yards southwest of No. 6. It is a conspicious mound of limestone 5 feet in height. A rock mound, probably representing an oven, shows near it. Many sherds are scattered about the site. The ruin is of Zunian type.

No. 9. This is a small conglomerate limestone mound 100 yards north of No. 8. Some sherds are scattered about the mound. The limestone had been carried for quite a distance from a lower level

No. 10. This ruin is one eighth of a mile south of No. 5. It is a mound of rock lying in a north and south line, 7 paces wide by 4 feet high, with a depression to the south of it. It apparently has the remains of outlying rooms in foundation on the east and north, and has a low adobe mound south of the depression.

No. 11. This ruin is one-half mile south of No. 10. It is composed of two rock mounds, one in shape of a turtle's back, with extending additions. This mound has a kiva depression south of it and much house-debris to the northward. The loop of the D to the southward was an adobe mound, not shown in the cut. The other mound has a smaller rock mound both north and south of it.

No. 12. This ruin is situated one-half mile north of No. 11. It was seen only at a distance, as time would not permit visiting it. It appeared to be very similar to No. 5.

No. 11½. This ruin is about a mile south of Ganado P. O. It is a large circular ruin 55 yards in diameter, situated along the road that enters Ganado from the south on the east side of Ganado (Pueblo Colorado wash). Its north walls were of heavy rock and now form a large pile. The rest of the edifice was evidently built mostly of adobe and now forms a low mound. A depression now occupies the plaza-site. Much pottery is strewn about, also a few fragmentary grinding stones.

This ruin was built on a more ancient ruin. The ancient village or villages were more extensive, now showing in a low mound and pottery fragments even across a canyada to the north, the canyada not existing in the time of the villages. There also extends north-

ward from this ruin a series of ruins for a distance of 500 yards. Part of these at least belong to the ancient group. One village of the series was in what is now an Indian cornfield. Its site is now leveled, the Indian saying that he found nothing of any value. If these sites were occupied at all simultaneously they must have contained from 500 to 700 people.

No. 12½. This is a D-shaped ruin 3 miles north of the Cornfields school south of the road leading to Ganado. It is a small ruin, the straight or northwest side being a massive pile of lime rock.

Nos. 13 and 14. These are D-shaped ruins of small size farther on along the same road toward Ganado from No. 12½. Their appearance would seem to indicate that they are older than the latter ruin.

No. 15. This ruin is on a hard-rock-topped bench just south of the white (McElmo-Tertiary) mesa 3 miles northwest of the school. The foundation of a circular room 4 paces in diameter shows. At present no other building appears on that level; but below the bench in the valley and in the cut-back ravines much broken pottery shows. The circular building seems to have been a watch tower, the village being built at the foot of the mesa-bench.

No. 16. A low mound in the flat about one-half mile southeast of No. 15 marks the site of an adobe village of considerable size. Many pottery fragments now mark the site.

No. 17. On a knoll in the flat between the first and second ridge about one-half mile southeast of the school there are the remains of what appears to have been a circular village probably 35 paces in diameter, now represented wholly by a circle of broken pottery and some scattered limestone.

No. 18. On the ridge directly south by southeast of No. 17 there begins a series of villages—debris in limestone mounds and broken pottery, extending eastward the whole length of the ridge, a distance of 300 yards. A western arm of this ridge at its eastern terminus has like debris on it. None of the rock mounds are large, and from appearance the greater part of each village-segment was of adobe, which has been dried out and blown away by the wind.

Across a saddle to the eastward from the main ridge there are a large and two small limestone mounds on a knoll which lies east and west. The two small mounds are on the west slope; the larger one tops the crest. No pottery was seen about them. The limestone of the mounds had been brought in from a point one-eighth of a mile away.

On a knoll in the flat 400 yards northeast of the last ridge there are the remains of 4 stone mounds of small size, probably representing a single-roomed house each, and around them and scattered about over the knoll there is much broken pottery. A little farther northeastward there are also the remains of a stone house still remaining in foundation.

Nos. 19-21. Across the next saddle to the eastward from the ridge on which the mounds represented by No. 18 are located, some 400 yards distant on the south slope of the ridge there are 3 limestone

piles, which run east and west: the longest being about 30 feet long by 10 feet wide, the others much smaller. Below each there is a considerable amount of pottery fragments, some stone and a few broken milling stones. Each village was apparently D-shaped. Fewer than 100 people lived in the largest village. Whether these mounds were segments of one village or were separate villages, not simultaneously inhabited, can not now be determined.

No. 22. About 500 yards northeast of Nos. 19-21 there is a small mound, around which there are a few scattered fragments of corrugated pottery. The site probably represents a grave.

No. 23. This ruin is on the east side of the bench 400 yards north of No. 22. The village was one of the D-shape type. The north-northwest wall was of limestone, the mound now being 4 feet high, 8 paces wide and 15 paces long. An isolated building of rock shows 4 paces to the west of this mound, and another 12 paces to the southwest of it. An adobe extension reached 30 feet toward the east. The circular-loop part of the village extended 30 paces southward in diameter from the main stone building.

No. 24. This ruin is 410 yards east of No. 23. It stands up as a massive pile with a Navajo altar topping it; part of the stone of the ruin has been re-used by Navajos in sweat-house ceremonies. There are now no indications so far as plan shows that anything other than the stone building was erected. Three kiva depressions show. The sherds are few and scattering.

No. 25. This ruin is one-half mile northeast of No. 24. It is a small circular ruin 24 paces in diameter. Its north tier of buildings was of stone. The sunken plaza still plainly shows. Probably 40 people lived in this village. Much black and white pottery appears in the debris.

No. 26. This is a ruin near No. 11½ near Ganado.

No. 26. This ruin is directly across a canyon and on the very edge of the same, one-eighth of a mile south of No. 11 (10). It is composed of a rock mound, with additions. On the southeast side the rock pile is 5 feet above the level of the plain and 4 feet on the northwest—the main mound lying in a general northeast-southwest direction. The mound is of limestone. But little pottery shows, and there are but few signs that this village was used other than as a watch tower and for storage purposes.

No. 27. This ruin is 400 yards west of No. 26. It is a low mound or rock 26 feet in length in a northeast-southwest direction. Some pottery shows.

No. 28. This is a high mound of limestone running 22 paces about north and south, being 10 paces wide at the base of the debris. Room walls show now and then. The mound is 8 feet high. It shows no plaza or other signs of ruins except scattering pottery fragments near it. But 45 feet southeast of it much pottery is being exposed, which probably represents a part of the outer rim of the adobe part of the D-shaped village, an arroya having washed the

other part of the adobe addition away. A depression northwest of the rock mound seems to represent a kiva.

No. 29. A rock-mound ruin 200 paces approximately south of No. 28 is 19 paces long in about a north and south line. It is 4 feet high and, including the lateral debris, it is 14 paces wide. The plaza of this D-shaped village is 30 paces across, the south part of the village having been of adobe, now represented by a low mound and scattered sherds. The plaza was open to the southwest.

No. 30. This is a similar ruin 129 paces west of No. 29. Its plaza was open both to the northeast and the southwest. Three depressions in the stone mound represent corresponding rooms.

No. 31. This is a similar but older appearing ruin 312 yards northwest of No. 30. It has an additional mound to the northeast of it, which probably represents a single room or an oven.

No. 32. This is a room similar to No. 30, 271 paces about south of that ruin. It had a detached stone room to the west of it. Its stone mound is 14 paces long. It is narrow. The diameter across the "D" is 39 paces. The village was so built that it damned a swale. Much broken pottery marks the site.

No. 33. A village similar to No. 30 shows about one-half mile northeast of that village. The writer visited it at sunup September 16. It stands on the northwest bank of a deep arroya. It is a double ruin. One stone mound is about south of the other. The south mound (marked "s") faces east. The north mound (marked "n") faces about southeast. The north mound is a straight line of rooms, the south mound circles a little toward the half-moon shape. Each are the west or northwest walls of D-shaped villages. The north mound is 4 feet high and the south mound much less.

Judging from the disintegrated state of the rocks composing the mounds, (s) is much older than (n). (N) shows a large depression that probably represents a kiva.

No. 34. This is a small ruin on the northwest bank of an east-west canyon where the trail crosses the canyon 4 miles nearly east of the school. The ruin appears very old. Its "great house" faced northwest and is 10 paces long. The whole village, across the "D", was 20 paces in diameter in a southeast-northwest direction. Its plaza openings were on the northeast and southwest sides. This ruin, as did No. 35 next, guarded a pass to the east over another mesa across the above canyon, where a series of springs come to the surface in a small vale.

No. 35. The remains of a small ruin appear on the west bank of the same canyon 400 yards east of No. 34. It was evidently made of adobe. Nothing but a circle of pottery fragments now remains. Probably 25 people lived in this place.

No. 36. This is a ruin in the flat about 2 miles nearly west of No. 34. It is now represented by a mound running 53 paces approximately northeast and southwest and about 35 paces in width. No rock appears about the site. Some pottery, however, shows all about it and all prairie dog holes on it show much pottery that has been thrown up by these animals in their digging.

No. 37. About three-fourths of a mile south of the school at the east foot of a high ridge there is much scattered pottery and some stone. No outlines of a village show.

No. 38. This is a ruin south of the north-leading Ganado road from Cornfields about a mile northeast of the school. The ruin stands on the edge of the northwest bluff-bench overlooking Pueblo Colorado wash. The plaza and the southeast part of the village have been washed away by the back-cutting of the wash. The village was D-shaped.

Nos. 39 and 40. This is a case of one village being superimposed on the ruins of another. The older village, No. 39, is probably Tusayan, the younger village Zunian.

No. 39. Some 140 paces southeast of No. 38 begin the remains of a very old village skirting the southeast and southwest edge of the mesa-bench which here forms a corner extending a total length of 187 yards. The broken pottery extends along the edge of the bluff the whole distance. The village for the most part must have been of adobe or it is so ancient that the limestone of its walls has disintegrated. The village was long and narrow, or a part of it has been washed away.

No. 40. As we have noted this village is much later than No. 39. It was a much smaller ruin. It had a northwest series of rooms of stone 37 paces in length. This stone part had a double tier of rooms. The southeast part of the village was circular and the whole village D-shaped. The southeast portion was built of adobe, some parts of which have now been removed by the cutting-back of the wash

No. 41. This ruin is in the flats one-half mile east of the Tertiary-McElmo bluff directly west of the school. It is now a low knoll. At this place, scattered over a large area, there show scattered pottery fragments and some rock, as the remains of a large adobe village, now much disturbed by cultivation.

No. 42. Topping the Tertiary-McElmo mesa about a mile due west of No. 41 are the remains of a small village, built probably of sandstone which has disintegrated and blown away. Many sherds mark the site.

No. 43. This ruin is at the head of a west-leading side canyon in the Tertiary formation 4 miles across Pueblo Colorado wash southwest of the school. It was a small affair. Some sherds cover the site. There are also indications that there was once a small cliff house right under it just below the top shelfing ledge on which the village was situated, the Tertiary here being capped with a hard sandrock. This ruin was evidently an outlook.

No. 44. This ruin is one-fourth of a mile southeast by east of No. 43, being situated on the very edge of the mesa overlooking the valley some 300 feet below. It was rectangular in shape. The outlines of 5 rooms still show, and much pottery marks the site. It evidently was a lookout village.

Note: The villagers did not build villages in the timbered regions about Cornfields and Ganado except to protect passes.

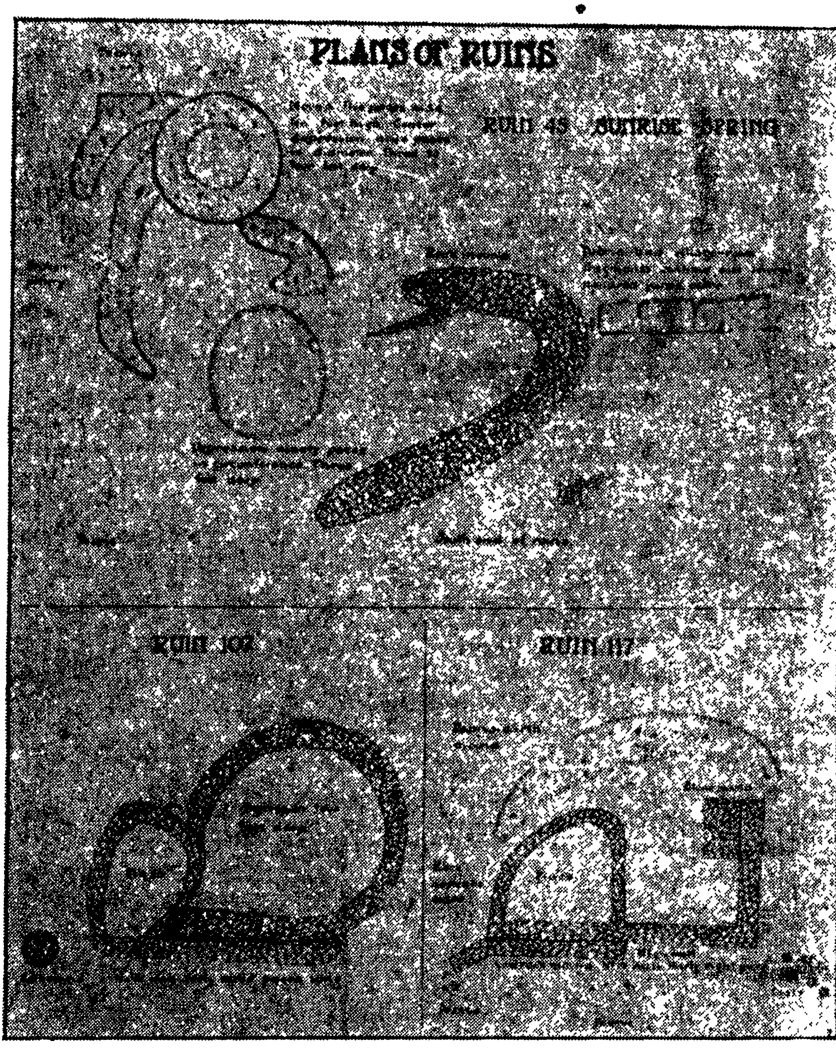


FIG. 1. PLANS OF RUINS.

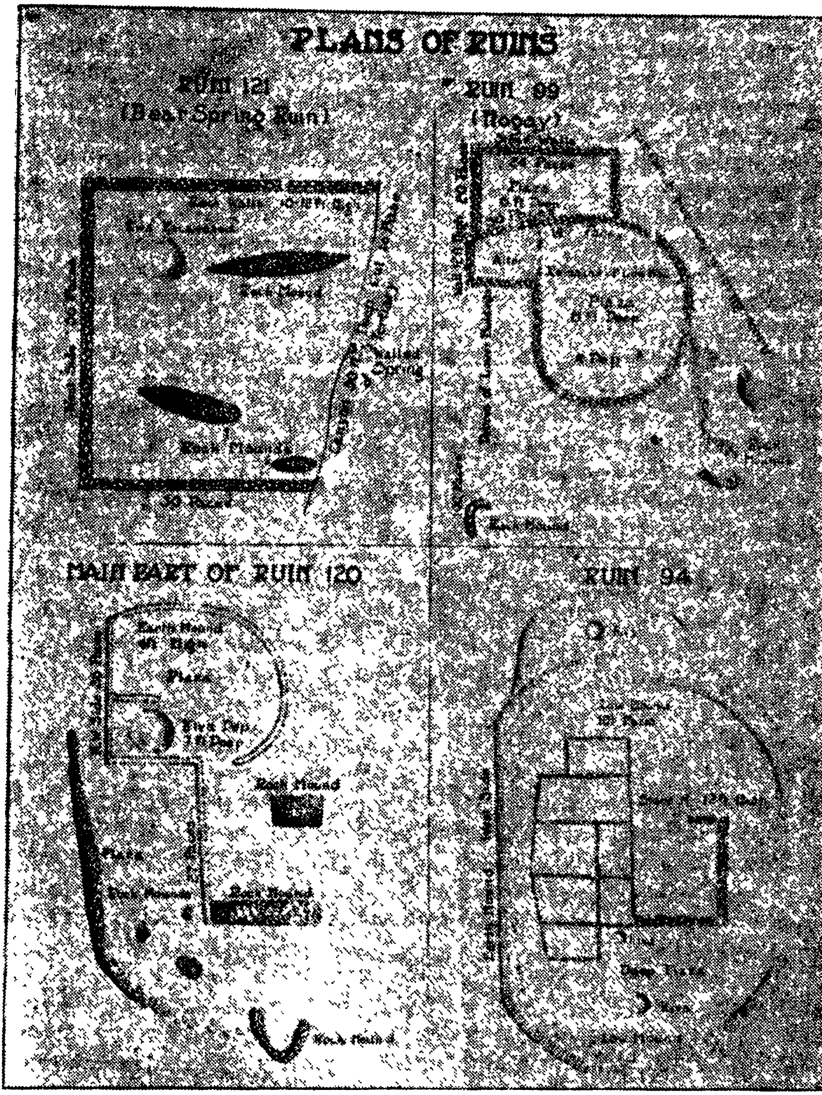


FIG. 2. PLANS OF RUINS.

No. 45. (See plan on map above.) This is a massive ruin topping the mesa one-half mile across the wash about east of Sunrise Springs store. Its shape reminds one of descriptions of "Sun Temple" ruin. It culminates in a circular edifice which was a large stone building several stories in height, so constructed as to view the whole country from its top. On account of its position and its near-

ness to Sunrise Springs the writer has named it "Sunrise Springs Ruin". Whether its central space was a kiva, a store room, living room, or a tower can not now be decided except by excavation, if then. Extending from it in descending levels there are several lines of fallen houses and also on the ridge extending eastward there are other village sections. A little southeast of the big ruin is a small circular ruin with a depression. Some pottery and a few foundation walls show. Considerable debris also flanks the main ruin on all sides, much of it having the appearance of having been house material of one story structures. Southeast of the main ruin and south of the big kiva (reservoir) there is much scattered pottery.

This kiva-depression, which is east of the tower-building, is the largest yet seen in the region by the writer. The village as a whole seems to have been built on the plan of the aboriginal idea of the shape of the sun's disk, with the tower as its center. So far as the parts now show it resembles the drawing of a sun emblem on a food bowl from Four-mile ruin. (Fewkes 8: Fig. 96 (number 77058), p. 150.)

It is the writer's belief that the tower-village was built last and that parts of the original (first) village were torn down to furnish material for this structure. The building material was sandstone from the base of the Tertiary (Chuska) formation which caps the mesa, having been carried in from quite a distance. Probably 500 to 600 people lived in this village when it was at the height of its power.

The position of this village is at a point on the east mesa, east of Pueblo Colorado wash, where the valley of that wash is narrowest. The valley widens in hour glass shape both above and below this point. The inhabitants of the village could command both the upper and lower valleys, and their position on this high point could also be easily defended. From their "tower" they could view the whole region and spy an enemy anywhere in the immediate vicinity. This ruin makes a conspicuous mound that can be seen for a distance of 8 miles both above and below.

There are also several ruins on the top of the mesa west of Sunrise Springs store.

No. 46. This is a ruin or series of ruins being uncovered by the shifting sand in the inner valley of Pueblo Colorado wash directly across (east of) the wash which is 300 feet east of Sunrise Springs store. Much broken pottery, some building stone, and a few house foundation walls now mark the site. Probably 100 people lived in this village.

No. 47. About a mile northwest of Ganado, just before the wagon road north of the wash crosses a small wash-arroya coming from the north, there are the remains of 4 D-shaped villages in a north and south line. They are all small, and contained probably fewer than 100 people each. A part of the straight north wall of each and much broken pottery now mark the sites. Another small D-shaped ruin was seen one-eighth of a mile north-west of the 4 ruins mentioned above.

Nos. 48 to 63 are at the foot and on top of the mesa directly across the valley about southeast of the Cornfields school and some 3 to 5 miles distant. The people of these villages farmed the intervening valley flats and probably got their water supply from wells and reservoirs in the same flats. A dam in an east-coming arroya (Sabito wash) northeast of the mesa now holds water and a large reclamation-inpounding dam has been recommended for this arroya at about the same site. (Many other of the ruins previously described may have had their farm lands in these same flats.) Practically all these ruins that are in such a state that the exact form can be made out are D-shaped. The straight-walled building of each one was on the west or northwest; it was built of stone, and was usually large; it now is represented by a massive pile of rock. The other parts of the building (village) in each case were of adobe construction, now represented by an earth mound. The ruins are all on Tertiary formations and the stone part of each was built of friable Tertiary sandstone. Hence the rock heaps are more deteriorated than the rock heaps of the straight sides of the D-shaped villages that were erected of limestone on the benches of the Chinle formation north and northeast across the flats 3 miles distant. They are apparently of the same age, as the pottery is very similar. Below is a description of each village:

No. 48 is a ruin in the "foothills" adjacent to and north of the mesa across the valley some three miles distant south 20 degrees east from the school. It was D-shaped and probably large. A great part of the village has now been removed by wash.

About 325 yards north of the above village on a ridge running north and south, there are indications in scattered pottery, etc. that there was a village there also. Its size and shape, however, could not be determined.

No. 49. On the mesa a little east by south of No. 48 there is a ruin of large size. On account of its poor state of preservation its original shape could not be determined.

No. 50. On the next projecting point of the mesa 400 yards directly east of No. 49 is another village. A depression of a kiva shows.

No. 51. Some 100 yards south of No. 50 is the ruin of another village with a large kiva depression 16 paces across, around which there is much broken pottery of large size. A circular ruin seems to have surrounded the depression.

No. 52. About 390 yards south of No. 51 on top of the mesa west of a south leading arroya the ruins of a stone village shows. It was built in the form of a square, the east and north walls being now removed by the enroaching arroya. The approximate west wall is 17 paces long. Remnants of the south wall show for 17 paces. Much pottery shows on the down-slope side toward the arroya. Two mounds of earth near to and on the west of this ruin both show

pottery fragments; and probably formed a part of the village proper.

No. 53. On the east edge of the mesa overlooking the arroya above and near the head of same, 421 yards south of No. 52 there is a stone ridge running north 20 degrees east. It is 12 paces long 4 paces wide, and 4 feet high. Directly east of this stone ridge, which is artificial, there is a circular basin 22 paces in diameter, and this, in turn, is surrounnded by a ridge of earth on all sides except that occupied by the stone-heap, the east part being 4 feet high, 16 paces wide and 20 paces long. This (earth) mound is covered all over with sherds and a few broken metates. No stone appears in the mound but the most pottery seen at Cornfields covers it. The village was D-shaped and was open on the north and south sides, the largest entrance being on the south side. The village was large and its "great house" high. It must have contained 300 people.

No. 54. On a point one-eighth of a mile directly east of No. 50 there is a circular ruin 34 paces in diameter. Much pottery marks the site.

No. 55. Inland, south of a sand knoll on the top of the mesa one-half mile southwest of No. 54, there is a D-shaped ruin with a straight stone-heap 12 paces long with foundations showing north 20 degrees east. A continuous low rock mound also extends east of it in an east and west direction 33 paces further.

No. 56. About 500 yards south of the last ruin on the same ridge a similar shaped ruin shows. It also shows great age.

No. 57. A small D-shaped ruin one-half mile west of No. 55 was noticed. It also seemed to show considerable age.

No. 58. This is a small D-shaped ruin on the top of a ridge south of No. 57. It is remarkable for its scarcity of sherds.

No. 59. This is a rock mound one-fourth of a mile west of No. 10. The outline of the D-shaped village still shows with straight west rock building 21 paces long. A depression represents a kiva. The east part of the ruin was adobe and was quite wide. Many sherds mark the site.

The stone heap has been dug into, exposing many sherds. The mound runs in a north and south direction. The plaza depression is 12 paces across.

No. 60. This is a D-shaped ruin 40 paces in diameter with straight rock wall 21 paces long.

No. 61. About 300 yards northwest of No. 59 is a D-shaped ruin with a rock wall 13 paces long. A large kiva depression shows south of the rock mound. Along the rim of the mesa southwest of the ruin for a distance of 30 paces there are the remains of houses and many sherds.

No. 62. This is a double ruin 220 yards southwest of No. 49. The segments are along the northwest face of the mesa. Both are more or less D-shaped. The southwest segment is much the smaller and looks to be the older of the two. The straight side of the

other segment is now a massive pile of rock and must have been 5 stories high. This mound is 17 paces long and 10 paces wide. The two segments are about 80 paces apart. The buildings of the loop part of each was of adobe, each covering a considerable area. Much broken pottery covers the site of each of these loops. Some 200 people lived in these two villages. The position of these two villages was commanding, overlooking the valley and fields below; and in the days of their glory these settlements must have presented a picturesque view, perched thus on the mesa's edge.

No. 63 and 63-a, b, c, d, e. This is another very large D-shaped ruin 323 yards east of No. 62. The rock mound of the straight side of the village is on the northwest face of the mesa and is large and wide. On a sand knoll a half mile east of No. 48 there is a large, almost round ruin. On the red mesa southeact of No. 63-a there are four small D-shaped ruins.

No. 64. This is a large ruin across the wash from the sheep dip, 460 yards east of Hubbell's store at Ganado. The ruin is a large stone affair, laid off in almost the form of a square, about 60 feet to a side. (It was not measured.) There are cross-sections. This building was constructed of rock and was a massive affair, as is shown by the huge heaps of stone that now mark the site. But very little pottery shows. Mr. Hubbell advised that digging in the debris brought nothing to light. The ruin is on private property. The wash (Pueblo Colorado wash) is now encroaching on the ruin and is now undermining its northwest walls. Houses seem to have occupied a ridge from this ruin almost halfway to Hubbell's store. These seem to have been of adobe and are now represented principally by broken pottery. This ruin probably belongs to the Tusayan group. It is undoubtedly older than the D-shaped ruins of the region.

This ruin was mentioned by Dr. Fewkes (8:127) who states "Pottery from this ruin is ancient, much older than from Kintiel." In Handbook of American Indians (11:v 2, p. 976) he also mentions it as follows:

"Wukopakabi ('great reed or arrow house')*. A ruined pueblo, consisting of a number of mounds very much worn down, covering a rather small site, at Ganado, on the road between Fort Defiance and Keams canyon, Arizona. It is locally known as Pueblo Ganado and Pueblo Colorado. It was inhabited in the ancient times by the Pakab or Reed people of Hopi, who migrated from Wukopakabi to Awatobi (q. v.). After the destruction of the latter village, in 1700, they went to the Middle Mesa of the Hopi and founded a town on the east side; subsequently they moved to Walpi, on the East mesa, where their descendents now live. These people, as their name signifies, were warriors, and traditionally they were related to the Zuni. Their descendents hold at the present time in December, a war celebration. —"Pueblo Colorado.—a local name. Pueblo Ganado,—Fewkes (8:127)

*The Navajo name of this village is Tal-a-hadi che'o'l ('valley place of round house or village).

(Span., 'sheep village,' another local name)."

No. 65. This ruin is about one and a half miles northeast of No. 10. It was very similar in construction to the latter ruin and was also large. Its straight side was 22 paces long and is 8 feet high in height of mound now, its circumference is 130 paces. No kiva shows.

Nos. 66-69 and 69 1-2. Some 7 miles west of the Cornfields school over in the Tertiary rounding hills and ridges there is a shallow "lake" of water a few hundred yards wide and one-fourth mile long in a naturally dammed up northeast branch of Steamboat (Hogay) wash. A sand dune has blown across the wash and has dammed the stream. About this valley many Navajos now have their sheep, running them in the hills and watering them at this pool. In the flat country about the lake the Navajos have also fenced in a considerable area for farming and pasture purposes. In the old times the village people used this valley, but were never a numerous population. On a ridge east of the wash about 2 miles northeast of the lake, sherds and some stone indicate the site of a very small village. South of the wash between this village and the lake there is considerable broken pottery in two different places on a sand ridge. On a sand ridge just east of the lake there are more scattered pottery and the outlines of a few house-rooms. A small village was also seen west of the wash, about a half a mile west of the well three-fourths of a mile north of the lake. It is here given as 69 1-2. The villages were all small and were either built of adobe or of friable sandstone which has crumbled to dust with age, though durable Tertiary sandstone was near, especially to the last two ruins. The appearance and smallness of the villages seem to indicate that they were possibly only "summer" or hunting villages, not permanent residences. In their present condition the shape of none of the villages but the last mentioned could be determined, 69 1-2 was D-shaped.

This slight settlement of this valley demonstrates that there was no permanent water in it as now. It moreover demonstrates that these ancients were not engineers or they would have dammed the valley as the sand dune has now dammed it.

No 69 3-4. These ruins are in the foothills of the Tertiary mesa east of Ganado Mission. One on a knoll is D-shaped; 3 nearer the mission were built of stone on all sides, one being triangular in shape. Also on a ridge nearer the mission there is another group of ruins. All except the first ruin seem to be very old, about the same age as No. 64.

No. 70. Fragmentary remains of a village are now being uncovered in an east bank of Pueblo Colorado wash about 7 miles above Cornfields school. Part of a well shows, also a fireplace 10 feet below the top of the bank where the village is being undermined by the stream. The writer was told that much more of a village showed up to a few years ago but has since fallen into the encroaching stream. The fact that the village is entirely covered over with 10 feet or more of stream wash shows that the valley aggraded itself after the place

was abandoned. The original size of the village can not now be conjectured. It is probably Tusayan in age.

No. 71. This is a ruin across the wash one-half mile directly west of No. 70. It is a ruin in the flat near the "Three Buttes", but northeast of the center one, about 2 miles southwest of Ganado. It is D-shaped and 197 paces in circumference, with straight side on the west. The straight side, made of stone, is 46 paces long. The original village had been added to, especially at the south. The original straight part, the highest part now, was 26 paces long; the added straight part is not so high by one-half. The adobe part of the village was large, now represented by a conspicuous, wide earth mound, over which many large pieces of broken pottery are strewn. Probably 200 people lived in this village.

No. 72. This ruin is one and one-half miles northwest of the Cornfields school. It is on a descending ridge from the highest finger-ridge-promontory that jots out northeast from the main white (McElmo) mesas northwest of the school. The village was in a north and south line (the direction of the ridge), was 100 or more yards in length, and was built in rectangular shape. It is now covered with a heavy drift of dune sand, with a wall showing only now and then. It was a village of large size. A characteristic thing about it is that decorated red ware is scanty, while old patterns and corrugated ware cover the whole southeastern slope of the ridge. It is the writer's opinion that this village is very ancient.

No. 73. This is a D-shaped ruin with straight-stone-building side 23 paces in length. It is situated on a Tertiary sandstone ridge one and one-third miles northeast of the lake that is 6 miles west of Cornfields. Its position overlooked the valley in which the lake is located. While the ruin was D-shaped its pottery seemed to be old and it had the corrugated ware predominating. The straight side of the village was built of Tertiary sandstone.

No. 74. On an isolated red (Wingate sandstone) promontory that projects eastward from the Tertiary-McElmo capped mesa 4 miles somewhat west of north from the Cornfields school, a massive pile of hardish rock of the capping stone of the Wingate series was observed. The pile was between 7 and 9 feet high, was rather wide, and was 22 paces in length. Five house-rooms could be distinctly made out. If this was the straight side of a D-shaped village, as its pottery shows that it was, the adobe part of it has been removed by time. The village was nicely located for observation and for defence, as an observer from its top, 400 feet above the valley, could have seen anything that might move in the valley for a distance of many miles both above and below the village fort. It, however, was open to approach from the higher McElmo-Tertiary mesa 500 feet to the west of it. It was probably built on the red promontory because of its view-position, because the rock there was durable. and because the narrow neck that connected it with the McElmo-Tertiary mesa to the westward could be easily defended.

No. 75. This is a D-shaped ruin on the bank northwest of Pueblo Colorado wash about 2 miles southwest of (below) No. 71.

76. This is a ruin in the flat near the Chinle mesa just east of the mouth of a north and south canyon 2 miles east of the school. It is D-shaped with the straight line on the north side, forming a big pile of stones. This ruin was found by Mr. Paul E. Gradall, the government stockman. A cross section through the long part of the loop of the "D" showed no walls, no burials and no whole pottery. It, however, showed that the place had been inhabited at two periods, with an adobe-sand stratum between the two layers of kitchen refuse. Besides Pottery fragments, several small bones were found in the lower stratum, but on account of their decomposed condition it could not be determined whether they were baby bones or bones of some small animal. One room of the straight side was also cleared, but showed nothing. Probably 100 people lived in this village, and each set of people lived there for a considerable time, judging from the pottery fragments. The village is on a little knoll that is flanked both north and south by small washes that come down from the Chinle mesa to the northeast. These washes open up on a little pocket-valley northwest of the village where the inhabitants of that far off time undoubedly had their cornfields and where there is evidence that Navajos have had their cornfields recently, though there are no fields there now.

Nos. 77 and 78. These are two small D-shaped ruins on a knoll which runs north .and south on top of the Tertiary mesa 400 yards directly west of Sunrise Springs. Judging from the size, not more than 40 people lived in either village. The ruins might have formed segments of a single village, but there is no evidence to show that they were.

No. 79. This is a small ruin in the valley flats about 2 miles north of Sunrise Springs. It is in such bad condition that its shape and size can not now be determined.

Nos. 80 and 81. Two ruins show on the north side of Sabito wash one-fourth and one-half of a mile respectively east of the first dam on the same, 3 miles southeast of the Cornfields school. They were not visited, but from a distance they showed the characteristic rock-pile formation of D-shaped ruins.

No. 82. This ruin is southeast of the wash on which Nos. 80 and 81 are situated, north of and about a half mile east of the latter ruin. It is on a sandy knoll and is D-shaped. The stone ridge of the straight side is 18 paces long and is composed of hard Chinle conglomerate limestone. Three rooms show on the ridge. The village was not occupied long. There are but few pottery fragments, and the adobe part is only a low ridge.

No. 83. This ruin is 417 yards north of No. 82 on the same side of Sabito wash. It is similar to No. 82, except its stone ridge is longer and higher. It faces south and shows four room depressions in its stone mound. There is also a depression south of the stone mound. The rock used in the construction of this ruin as well as the construction of No. 82 was carried quite a distance, probably half a mile. The main stone ridge is 16 paces long. An additional room had been

added to the west end, set a little south of the main ridge, which gives the stone mound a little curved appearance. The mound is 4 feet high. The part of the village south of the "great house" is 32 paces deep. The adobe section is now a low mound and the pottery is scanty. The village evidently was not occupied long.

Note: Nos. 80-83 obtained their water for farming and irrigating from Sabito wash, doing their farming in the valley of this wash adjacent. They also probably used the water of a series of springs a half a mile distant to the northwest for house-cooking use when the water of the wash failed.

From these ruins eastward to Cross-Canyon a distance of 17 miles through an open valley and a part of the time through an open country no ruins were seen. The greater part of this distance is over Tertiary sands with no rock and this may account in part for the fact that we did not see the characteristic stone-pile ruins, the villages having been built of adobe which has disintegrated. But near Cross-Canyon there is stone and yet no mounds of villages were seen. It is the writer's opinion that the villages are few in that section because it is distant from water needed for irrigation.

No. 84. This ruin is on the top of an isolated low butte of Navajo-Wingate sandstone in the valley north of Pueblo Colorado wash 4 miles south of Sunrise Springs. The stone mound resembles a long sausage 4 feet in height curved almost to a half circle and so placed as to have its opening facing south. The village is 89 paces in circumference, the adobe part being a considerable mound. Much pottery marks the site, indicating that the village was long occupied. It commands a long flat area along the wash adjacent.

No. 85. This is a small ruin on the top of the Tertiary mesa one-eighth of a mile west of No. 84. Scattered rock and pottery fragments mark the site. Its size and shape can not now be determined.

No. 86. This is a small D-shaped ruin near the top of the divide between Steamboat (Hogay) wash and Pueblo Colorado wash, one-fourth of a mile west of No. 85. Its stone mound is composed of Tertiary sandstone and volcanic tuff. Cnsiderable pottery marks the site.

No. 87. This ruin, or set of ruins, skirts the west benk of Pueblo Colorado wash for a distance of more than 700 yards, a mile south-west of Ganado. The ruins comprise two series, one superimposed on the other. The latter so far as the writer has observed, consists of 3 D-shaped ruins, at varying distances from each other of over 200 yards. The former appears to have been a series of rectangular segments, now leveled and covered with shifting silt and blown sand. The D-shaped villages are undoubtedly Zunian. The pottery of the first (oldest) ruins is very ancient, apparently belonging to the same series as the ruin near Hubbell's store (No. 64) across the wash a mile and a half distant, placing it in the probable Tusayan group.

The encroaching wash is now undermining this series of villages, exposing the old house-foundations, fire places, ash heaps, and the interments in the ancient graveyard. Seven skeletons now show in

the river bank. One of these was buried in a cist, a fireplace had been built over another, and the corner of a wall is over another.

One peculiar thing about this village and its burials, as with No. A-1, is that the skeletons exposed by wind and water were buried without any pottery being placed in the graves. Moreover, in the burials in No. 87 fragments of baskets were found with the skeletons. Have we found a Basket-making people living in villages? Only systematic excavations can determine this vital question.*

No. 88. This is a small D-shaped ruin at the top of the mesa southwest of the road leading southeastward from the Petrified Forest to the top of the mesa southeast of Pueblo Colorado wash 3 miles southeast of Ganado. It was built of Tertiary sandstone and adobe. Probably 25 people lived in it. Its place was commanding as a view-station for which it was probably used. A similar ruin was seen on top of the same mesa one mile further south, and another across a canyon two miles still further south.

Ruins in the Steamboat (Hogay) Region.

Eighteen miles nearly west of Cornfields is Steamboat Canyon at the mouth of which is Steamboat trading store, called Hogay by the Indians. A mile west of the store Steamboat Canyon's waters reach a south-southeast flowing wash, called Steamboat or Hogay Wash. This wash heads far northward in the Black Mesa, Salahkai Mesa country, finally joining Pueblo Colorado wash 20 miles below Sunrise Springs. It drains an area as large as the state of Rhode Island and runs over and cuts through a diversity of rocks. Mesaverde, Mancos, Dakota, McElmo, and Tertiary. In its middle course about Steamboat (Hogay) where it is usually a dry wash except of course in the rainy season, it has cut through the Dakota far into the McElmo. Also to the eastward of this wash Steamboat Canyon and other side canyons have cut far back into the Dakota and through it into the McElmo for miles, leaving finger ridges extending westward, capped with Dakota rocks, sandstone, shale and coal. The sandstone of the Dakota is hard and resists weathering and consequently is good building material. The high, fingered ridges made good building sites for the peoples of the long ago. By hoarding the water supply of the springs, side canyons, and that of the main wash, by retaining dams, they had water for village use. By the use of this retained water and the flood waters in summer they were able to raise crops in the valleys. The valley flats of the side canyons and main wash are wide and of good land, that of the main wash being from a mile to 2 miles wide in some places. Not only did they raise crops by irrigation but probably by dry farming, as could be done today. Along the wash below Steamboat every available side wash and spring was used. Consequently a large population once lived in this region and a surprisingly large number of villages occupied the finger-like mesa-tongues that project westward from the main mesa northeast of Steamboat and Steamboat (Hogay) Wash. Below is a description of the ruins visited.

*This series of villages was discovered by Mr. Paul E. Gradall.

Ruins east of the first northeastward encroaching side canyon as one nears Steamboat from Cornfields. On proceeding to Steamboat from Cornfields by the northeast route over the top of the mesa, a canyon 150 feet deep cut through the Dakota far into the underlying White McElmo, suddenly looms up in front of one and he is compelled to change his course southwestward almost to a south direction. At this time he views with awe the black coal-capped mesas with their underlying white collars and tunics of McElmo sandstone, a series of villages of small size loom up in the foreground, probably outposts for the villages at Hogay and Steamboat. Those visited were as follows:

No. 89. This ruin is on the very edge of the canyon on the bench east of it, 2 miles east of Steamboat. It is a double ruin, both segments being D-shaped. The straight side, rock-pile mound of each shows rooms. The rest of each was made of adobe. The straight side was on the west facing the canyon. Considerable broken pottery marks the site.

No. 90. A small D-shaped ruin was seen about 600 yards southwest of No. 89. Considerable pottery marks this site.

No. 91. This is a D-shaped ruin 1 mile south of No. 89. While it approaches the D-shape, it also inclines somewhat toward the circular type, more than most of the ruins of the region. Its north line is a massive pile of rock, its south section a large adobe mound. There are indications that there were also outlying buildings. The plaza is now represented by quite a depression. Much pottery now marks the site and is scattered over quite an area about the ruin.

No. 92. Across the widening mouth of the above canyon on a ridge around another point northwest of No. 91, northwest of and adjacent to the road, there is a considerable ruin with a massive pile of rock for its northwest line of buildings. It was D-shaped and must have had at least 100 inhabitants. Its condition shows much age, and much pottery is scattered all about it, indicating that it was inhabited for a considerable time.

No. 93. This ruin is about one-half mile west of No. 92. It is on the northwest side of the road and close to it. Many pottery fragments of large size, a few foundation walls, a kiva depression, a plaza depression, and the characteristic rock heap still show. The village was D-shaped and of about the same size as No. 92. Like that village it has the appearance of being very old, though belonging to the Zunian group.

Ruins about Steamboat (Hogay). The trader's store at Steamboat is situated at the west point of the south lobe of the mesa that faces Steamboat Canyon on the northwest. The mesa is capped with 120 feet of Dakota rock, showing much coal; a mine at the store, from which coal is now being furnished for the Ganado Mission, shows a 5 foot seam of coal, 6 inches of hard slate and then a foot more of coal. As one proceeds northeastward up the canyon the McElmo formation, which shows at the base of the Dakota at the store, gradually rises and the mesa becomes correspondingly higher. Some distance northwest of the store a side canyon cuts into this mesa

running back for a half a mile, leaving a northwest lobe to the northwest of it, which, in turn, is flanked on the northwest by the main Steamboat (Hogay) wash. This lobe also has a small projecting lobe on its northwest front a mile and a half northwest of its westernmost point. These lobes are wooded and are more or less narrow promontories in shape and height. Here among the pinyons and cedars the ancients erected an incredible number of villages—these people seemingly preferring the wooded districts to open areas in direct contrast to the peoples about Pueblo Colorado wash valley. Below are the ruins examined, the ruins being located for the writer by Mr. Paul E. Gradall and Mr. Ernest Fautz of Steamboat store while he examined them, so as to facilitate the work:

No. 94. (See plan on page 159.) This ruin is on top of the mesa one-half mile north-northeast of the store. It is the first village on the mesa as one proceeds northeastward from the store. It is composed of a central building of stone, in which several rooms show. This, from its position, was evidently the citadel of the place. Surrounding this center is an oval mound which represents a circle of buildings. Some rock was used in the construction of the part of the mound west of the central edifice, the rest was evidently of adobe. Some excavation work has been done at the place. Many pottery fragments show all about the ruin. The village was large. At the north an addition was added after the main structure was completed. This village had probably 200 inhabitants.

No. 95. This is a very old circular ruin about 400 yards southeast of No. 94. It is represented by a large depression and pottery fragments. It was probably built of adobe, as no rock shows.

No. 96. This is a rectangular ruin, 62 paces long by 35 paces in width and running north and south. It shows 2 plazas. The west-wall building was of heavy rock and is now a crumpled pile of disintegrated stone.

A depression surrounded by a raised rim shows 100 yards southwest of this ruin. Whether a plaza, a reservoir, or a ruin was not determined.

No. 97. This is a ruin about due northwest of No. 94 on the west edge of a mesa. There is also a more recent small D-shaped mound as an addition on the northeast side of this ruin.

No. 98. This ruin is represented by parallel piles of rock, a kiva depression, and much broken pottery shows on the east face of the mesa. Probably 100 people lived in this village.

No. 99. Hogay ruin. (See plan page 159.) This ruin is about a mile up on top of the mesa northeast of Steamboat store and about a mile northwest of Steamboat Rock. It is in the main in circular form with added additions. It is the largest ruin in the Steamboat region and the largest circular ruin yet seen by the writer. It is next in size to the circular ruin at Eighteen-Mile Spring and Kintiel; the walls of the first ruin are reported to be still 8 and 10 feet in height. Its center was a circle of buildings built of stone, with a "tower" building on the northwest. The circular part, exclusive of the "tower", is 149 paces in circumference. The "tower-"mound is now

capped with a Navajo altar. The circular plaza is now 8 feet deep, and the massive rock-mound surrounding it stands 10 feet above the land around it. A rectangular stone-walled addition 20 paces by 24 paces was added to the main stone structure on the east after the circular part was completed. Several detached mounds of stone representing village segments also show to the west and southwestward of the circular part. About the ruin there are heaps of debris that probably represent adobe additions, refuse heaps, and burial mounds. Some pot-hunter has dug up all these earth mounds without leaving any record of his finds, so far as the writer can learn. The village, including its additions, was of large size. Probably 400 people lived in it when it was in the height of its power.

The circular-ringed mound, added "tower", and eastern addition appear to be a more recent village than the villages represented by the smaller ruins of the section, probably being on an older site. It was in this, probably, that the villages in the vicinity made their last stand before being driven from the country.

No. 100. Some 400 feet northeast of No. 99 (Hogay Ruin) across a little draw there is the ruin of another D-shaped village, 34 paces in length on straight side, and 41 paces in diameter across the loop, There has been much excavating in the loop-part. Many pottery fragments show.

No. 101. This is a D-shaped ruin that appears among the pinyons one-eighth of a mile northeast of No. 99. Many sherds are seen here.

No. 102. Inland 1 mile northeast of No. 99 (Hogay Ruin) and 500 yards nearly north of Steamboat rock there is a triangular ruin, 16 paces at base, northwest wall 32 paces, and southeast wall 30 paces. The northwest wall is longer than the triangular part, of which it forms part of one limb. The rock mounds are now 4 feet high. This is a ruin of one of the recent villages, judging from its appearance. Much broken pottery of large size marks the site, especially on the east and southeast sides.

No. 103. Across the second wash on the second lobe-projection one-half mile west of No. 99 there are two circular villages and an elongated one. Of course they may be segments of the same village, as they are close together, but only by excavation and by the examination of the pottery of each could it now be determined whether they were occupied simultaneously or not. They are at least very similar in structure.

No. 104. About a mile south of No. 103 there is a D-shaped ruin having its northwest tier of buildings of stone 33 paces in length, and 24 paces in width, with the diameter of the loop part of the "D" 24 paces. It was noticed that the sraight side was wider than is customary for the stone-mound side of the D-shaped villages, seemingly to have three tiers of rooms paralleling the ridge.

No. 105. A small ruin of the old type was seen one-eighth of a mile southeast of No. 104. As it was getting dark when the writer found it, this ruin was not examined.

No. 106. This is a ruin across the first canyon on the second lobe of the ridge about a third of a mile northeast of No. 99. It is the ruin of a D-shaped, almost circular village, now containing a depression which probably represents a kiva. Most of the walls were built of stone, the largest buildings being on the west and northwest.

No. 107. (See plan on page 158.) This is a ruin with a double plaza depression, 400 yards southwest of No. 106. Its northwest line of buildings, now a mound of rock, was built of stone 43 paces in length. A part of the walls of the smaller segment were also of stone. The straight side of the larger segment was of a double tier of rooms. The rest of the loops were of adobe. The plazas are now 4 feet deep. The mound southeast of the larger plaza is quite wide. Much excavation work has been done in the adobe part of this village and about the refuse heaps. A stone heap was noticed northeast of the ruin, probably representing an ancient oven.

No. 108. About 400 yards southwest of No. 107 there are the remains of a very ancient village. It seems to have been very large and circular. It is now represented by a depression surrounded by a raised rim, about which there are scattering pottery fragments. No rock shows.

No. 109. On a small northwest lobe of the mesa one mile west of No. 108 there is a very small D-shaped ruin. Another small ruin of about the same size was seen about a quarter of a mile northwest of No. 109. Judging from their small size these seemed to be outpost villages.

No. 110. This ruin is on the southeast face of the mesa one-fourth of a mile northwest of Steamboat store. It was D-shaped and faced the morning sun. Some of the walls show, but the village as a whole is in a poor state of preservation.

No. 111. Some 100 yards down the ridge southwest of No. 110 there is a circular depression 147 paces across, surrounded by a raised ridge of adobe-sand and decomposed rock. Considerable pottery shows. It evidently represents a very old ruin judging from its surface appearance.

No. 112. About 77 paces down the ridge southwest from No. 111 there is a double D-shaped ruin with quite a deep circular depression south of the stone wall of which the northwest part was built. This part of the wall stands up as a conspicuous mound. The northeast part of the village looks older than the other part.

No. 113 About 110 paces down the ridge southwest another ruin shows. The village was of considerable size, but is now almost leveled.

No. 114. This is a very small ruin. The village was built in the form of a square with northwest and east tiers of buildings of stone.

No. 115. This is a very small ruin 500 yards northwest of No. 114.

No. 116. This is another small ruin nearly west of No. 115. Both it and No. 115 were D-shaped with west line of buildings of stone.

Two other much older ruins show on farther down toward the

point of the mesa, the last one being quite large and both being more or less D-shaped.

Note: In the vicinity of these ruins in the canyon towards Steamboat store there is a seeping spring and around the point toward the main Steamboat (Hogay) wash is Sheep springs, from which there is quite a flow of water. There were probably other springs near these ruins in the old times.

Ruins down Steamboat (Hogay) wash from Steamboat to Bear Spring

Down the Steamboat (Hogay) Wash from Steamboat store for a distance of about 8 miles the white McElmo crops out in the valley while the blacker coal shale bearing Dakota formation flanks the valley on each side, forming a bluff series of from 50 to 150 feet in height on the northeast side of the stream; the southwest side of the wash was not visited. And again on this northeast side each cutting-back canyon runs back for several miles while the residual segments of the Dakota between these side washes jot toward the main wash in promontory form. Moreover, just before reaching Bear spring the capping rock changes from Dakota to Tertiary of the Chuska epoch. Yet the promontory-like projecting mesa-segment still continues. Furthermore, throughout the whole distance these projecting tongues have been village sites in the old times, where the peoples of those far-off times could view out the land and watch for approaching enemies, as well as overlook their farms in the valley. The largest villages were at Bear Spring and another spring 3 miles northwestward up the wash. Below are descriptions of the villages visited:

No. 117. (See plan on page 158.) About two miles southwest of Steamboat store a side canyon has cut back into the first mesa southwest of that store. On the northwest lobe of this mesa approaching the promontory part towards the southwesternmost point near its northeastern rim there is a medium-sized ruin. Its northwestern tier of buildings forms a right angle with a southeastern-extending wing so that the two almost represent a capital L in shape. The upper half of the stem of the L which is here thickened, forms the base of a D-shaped village, walls of which were all built of stone. The stem has a small addition added to it at its top in an outward slant from the main stem. Much village-debris and scattered pottery extends west and northwest of the L-stem. And southeast of the whole ruin here is a semicircular earth mound of village debris of what was probably an adobe village, graveyard and rubbish heap. Southwest of the ruin 4 sites of cist-shaped inclosures show on the hill-side in the form of little squares inclosed in slab-rocks set on end. The writer dug up one of these and it proved to be a "ventilator" to a grave, a small opening leading up through this cist-like box from the head of the grave. The writer examined the Ghostute (Goshute) graveyard at Deep Creek (Ibapah), Utah, years ago and the interments were there made with just such "ventilators" "through which the spirit of the dead could come and go at will in visiting the body," so the chief medicine men asserted. The writer

even saw the woman who was killed by Joe Lee's sheep, and a Mrs. Pon Dugan buried in that way. How many more house people were buried thus in this place and what relation these people were to the ancestors of the Goshutes, if any, can not now even be conjectured from the present meager knowledge of the burial customs of this people. It is hoped that more such graves can be found in the undisturbed state, so that definite data can be obtained to establish the relationship. (The other cist-like enclosures seem to have been cooking places.)

No. 118. This ruin is represented by an irregular pile of rock with some wall outlines showing, 86 paces south of No. 117. It was small and inclined toward the D-shape. A mound probably representing an oven shows northwest of the main mound.

No. 119. On top of the mesa east of the wash 2 miles below No. 118 there is a small D-shaped ruin built on top of another and larger ruin.

No. 120. (See plan on page 159.) About 700 yards southeast of No. 119 across a northwestward extending side wash-canyon there is a large ruin, showing considerable age. Its northern part is D-shaped and seems to be the last part erected, though excavation might determine otherwise. Some 400 yards southwest of this ruin there is the ruin of an apparently very old village, now leveled. And on a promontory 40 yards west of this village and about the same distance from No. 120 there is the ruin of a "tower". Some broken pottery, and a large pestle hole and three smaller ones, 10 inches and 4 inches in diameter show in the rock floor. Whether these three house clusters represent villages or segments of a single village can not now be determined. With the writer's hurried examination, it could not be determined whether parts of the different segments are older than the others, though from surface appearance some parts seem to be much older.

This set of ruins commands a spring in the valley adjacent to the northwest of a projecting ridge of basic Dakota sandstone capping the McElmo formation at that location. The Navajos now have the spring walled up and use it as a watering place for their stock, also obtaining their water for house use from it. It is not a large spring, yet it would furnish water for quite a village as the villagers lived in that long ago. The tower-lookout was no doubt built overlooking it so as to protect this spring as well as view out the country. This village (or group of villages) was built to command this spring, and the villagers did not leave such an admirable site adjacent to ample farm lands without being driven out of it.

No. 121. Bear Spring Ruin. (See plan on page 159.) In a side wash which projects approximately about north half a mile north of the main Steamboat (Hogay) Wash there is a spring issuing from the base of the Chuska Tertiary 50 feet below the mesa top, the canyon here being probably 60 feet wide and 50 feet in depth. The spring is walled and seems to furnish quite a quantity of water, judging by the Navajo camps in a 2-mile radius of it, whose stock and families must get their water from this spring. Moreover, as

now, this was a large spring in the days of the villagers.

Abutting the canyon wall and extending up to it on the west side of the canyon facing the spring there is a rectangular ruin whose fallen house-walls now form a massive pile of Tertiary rock. Probably 250 people lived in it when it was at its best. The west side of this ruin is 56 paces in length, its south row of buildings, 30 paces, and its north row still longer. The canyon formed the east line, its walls being almost perpendicular on this side. It and the three house-walls inclosed a court or plaza. The mound of the house rooms on the three sides is now from 10 to 12 feet in height. The remains of three rock structures still show within the court, as does a circular depression which probably represents a kiva. One room of the north house-series has been dug into, exposing many pottery fragments. Some small rooms along the canyon front have also been excavated, and considerable digging has been done in the kiva, where human bones were found,—a human femur now lying on top of the dirt thrown out. A recently abandoned Navajo stone house now stands 300 yards south of the ruin.

The village was built on the site not only because of the water in the spring, but to hold the spring, and the villagers did not abandon its living waters and their farm lands in Steamboat (Hogay) Wash adjacent without being driven from the site.

General Discussion

As stated previously, the ruins of the last series of villages built were undoubtedly Zunian. This, as we have said, is borne out by both Navajo and Zunian Traditions. The Navajos also assert that the villagers here were continually at war with each other and with the Athapascan peoples for a long time. They then divided and a part of them went to the Hopi country, as we now know that region, and the rest went to the region of the Zuni, so the medicine men have related to me just recently. This, too, is borne out by the traditions, as parts of the same clans now live at Zuni and Hopi. (Fewkes 8:-p. 124). Moreover, the Navajos have a Zuni clan incorporated in their tribe, the descendants of captured Zuni women at the time the Zuni were expelled from the region. The name of the clan is Nanashthezihn, black-horizontal-stripe aliens (Zuni). Also, according to Cushing, (11:vol. 2, p. 1016), the Zuni are derived from two parental stocks, one of which came originally from the north, the other from the west or southwest, from the country of the lower Rio Colorado. The latter, who resembled the Yuman and Piman tribes in mode of life, joined the others after their settlements in the Zuni valley. To this nucleus there were many accretions from other tribes and stocks, as well as many desertions from it, in both prehistoric and historic times."

In writing of the Asa phratral organization of the Hopi, Dr. Hodge (11:vol. 1, pp. 99-100), states: "Asa ('tansy mustard'). A phratral organization of the Hopi, comprising the Chakwaina (Black Earth kachina), Asa (Tansy mustard), Kwingyap (Oak), Hosboa (Chapparel cook), Posiwu (Magpie), Chisro (Snow bunting), Puchkohu (Boome-

rang hunting-stick), and Pisha (Field-mouse) clans. In early days this people lived near Abiquiu, in the Chama region of New Mexico, at a village called Kaekibi, and stopped successively at the pueblos of Santo Domingo, Laguna, Acoma, and Zuni, before reaching Tusayan, some of their families remaining at each of these pueblos except Acoma. At Zuni their descendents form the Aiyaho clan. On reaching Tusayan, the Posiwa, Puchkohu, and Pisha clans settled with the Hopi Badger clan at Awatobi, the remainder of the group continuing to and settling first at Coyote spring near the east side of Walpi mesa at the site of modern Hano. This village the Asa afterward abandoned on account of drouth and disease, and went to Canyon de Chelly, about 70 miles northeast of Walpi, in the territory of the Navajo, to which tribe many of their women were given, whose descendents constitute a numerous clan known among the Navajo as Kinaani (High-standing house). Here the Asa lost their language, and here they planted peach trees in the lowlands; but a quarrel with the Navajo caused their return to Hano, at which pueblo the Tewa, from the Rio Grande, in the meantime had settled. This was probably between 1700 and 1710. The Asa were taken to Walpi and given a strip of ground on the east edge of the mesa, where they constructed their dwellings, but a number of them afterward removed with some of the Lizard and Bear people to Sichomovi."

In writing on the subject "Cliff-dwelling", Mr. Holmes (11:vol 1, p. 306) makes this statement concerning the Asa people's wandering: "A well authenticated tradition exists among the Hopi that about the middle of the 18th cenury a group of their clans, the Asa people, deserted their village on account of an epidemic and removed to Canyon de Chelly, where they occupied cliff-shelters for a considerable period, intermarrying with the Navajos."

In writing about Walpi, Dr. Fewkes (11:vol. 2, p. 902), makes the further statement about the Asa clans of the Hopi: "The Asa clans migrated from Zuni."

In writing about the Hopi village of Sichomovi, this further statement (11:vol. 2, p. 563) concerning the Asa clans is made: "The Asa people were Tewa in kin, coming originally from the Rio Grande valley and settling successively at Zuni and in Canyon de Chelly. This people, with the Honani, founded Sichomovi, and is now one of the strongest clans on the East mesa, Only one or two members now live at Walpi; a few live in the Middle Mesa villages, but none at Oraibi."

In writing of Shipapulima, and Zuni heaven, Dr. Hodge (11: vol, 2, p. 551), gives information as to the Zuni belief as to their origin, as follows: "Shipapulima (Zuni: 'mist-enveloped town'), from shipia 'mist', ulin 'surrounding', imona "sitting place of.'—Cushing). The Zuni name of the traditional place of origin as well as the final resting place of the Zuni, Keresan, and other Pueblo tribes, whence came the gods who taught them their arts, agriculture, and ceremonies. By the Zuni it is said to be a group of pueblo ruins on the Rio Mancos, a tributary of the San Juan, in southwest Colorado; to the Rio

Grande pueblos (called by them Cibobe) and the Jamez (to whom it is known as Uabunatota) it is a lagoon in the same locality."

More information is given by Dr. Fewkes (11:vol 1, p. 564), concerning the make-up of the Zuni stock in his Hopi treatise, as follows:

"The ruins along the lower Little Colorado, near Black Falls, known as Wukoki, and those called Homolobi, near Winslow, are . . . . claimed by the Hopi as the home of ancestral clans. Wukoki may have been inhabited by the Snake people, while the inhabitants of Homolobi were related to southern clans that went to Walpi and Zuni."

Dr. Hodge (11:vol. 1 p. 259), also makes this statement concerning the movement of Zuni clans under the subject "Chichilticalli": "Owing to the glowing account of the place (Chichilticalli—red house) given by Fray Marcos de Niza in the preceding year, Coronado and his followers were 'much affected by seeing that the fame of Chichilticalli was summed up in one tumbled-down house without any roof, although it appeared to have been a strong place at some former time when it was inhabited, and it was very plain that it had been built by a civilized and warlike race of strangers who had come from a distance' (Castaneda). The same writer also states that it 'was formerly inhabited by people who had separated from Cibola. " (The ruin was seen before reaching Zuni, so was south of it, probably in the southern part of Arizona, somewhere in the Gila country.)

In speaking of the ruins of Kinnazinde and the two Kintyels (Kintiels), the one near here and the one in Chaco canyon, the following short statement (11;vol 1, pp. 691 and 698) is made attributing their building to clans of the Zuni tribe, as follows:

"Kinnazinde (probably Kinazhi, or Kiniazhi, 'little pueblo'—also spelled Kinna Zinde). The Navajo name of a small, ancient, circular pueblo near Kintyel (q. v.), Arizona, believed to have been occupied by the people of the latter place as a summer settlement.

Kintyel (Navajo: Kintyel or Kintye'li from kin, 'pueblo house', tyel 'broad', 'broad house'—Matthews; also spelled Kintiel and called Wide Ruins.) An unusually large, ancient, circular pueblo ruin on Leroux wash, about 23 miles north Navajo station on the S. F. Pac. R. R., Arizona. According to Zuni traditions the village was built by the Hlteetakwe, during the migration of the Bear, Crane, Frog, Deer, Yellow-wood, and other Zuni clans. The Zuni origin of the pueblo has been borne out by archaeological study of the ruins."

"Kintyel. A ruined pueblo in Chaco canyon, N. W. N. Mex. It figures in Navajo legend as in course of erection during one of their early migratory movements and later as a ruin. Its builders are not known (though supposed to be Zunian and same is born out by Navajo traditions.—Fewkes). As previously noted, Fewkes (8:p. 127) makes this statement in a footnote.

"The name Kintiel, or Broad House, is applied by the Navajos to at least two circular pueblo ruins in the southwest. One of these is the Chaco canyon, and is said also to have been contructed by the Zunis."

It would seem from the above that the Asà clans, once a part of the Zuni, traveled about all over the Pueblo country, living for longer or shorter periods at different places. Then they finally went to Hopi and from there they went to Canyon de Chelley 45 miles northeast of Cornfields, where they built many villages and cliff-houses, probably going there through the Steamboat-Hogay gap. There they lost their language and there their women were taken by the Navajos till in sore straits they returned to Hopi where they now form a part of the inhabitants of two of the villages.

And again we find that part of the Zuni clans came from the north and that they believe that their ancestral home was a group of pueblos on the Rio Mancos, a tributary of the San Juan in southwestern Colorado. There is also traditional evidence that many of the gentes of the ancestral pueblo migrated northward-northwestward from Zuni at a later time, subsequently returning to the parent village. There is also ample evidence, as the writer has shown in his previous reports, that the Hopi and Rio Grande pueblos wandered back and forth over the plateau country both in recent prehistoric times, and also in historic times, and it is likely that in the more remote prehistoric times they similarly roamed about, each of their migrations leaving a group of villages to puzzle the archaeologist.

Now about the villages themselves. So far as surface observation can tell, they all had circular kivas, unless it is the large ruin at Hubbell's store (No. 64). On the other hand, neither the Hopi nor the present Zuni have circular kivas. "The circular kivas of Kukutcomo, the twin ruins of the mesa above Sikyathi, near Walpi, are the only ceremonial rooms of this form known from the Hopi mesas. These were the work of the Coyote clan and are of Eastern origin." Fewkes. But Dr. Fewkes is of the opinion that the present rectangular kivas were derived from the circular kiva or are modifications of it. On this subject he says: (12:pp. 23-26.)

"There is no architectual feature in southwestern ruins more distinctive than the ceremonial rooms, or kivas, but as these have never been recognized throughout a large part of Arizona, it is important to determine the character of the ceremonial rooms of the Navajo Monument ruins and to compare them with kivas at present used by tho Hopi.

"While as a rule there is great similarity in secular rooms in different culture areas of the southwest, the more archaic ceremonial rooms of these regions vary considerably. The rooms ordinarily called kivas are of two distinct types, circular and rectangular. There are two kinds of circular kivas,* one having pilasters and banquettes to support the roof, the other without pilasters, apparently roofless, but surrounded by high walls as if for the purpose of obscuring the view from the neighboring plazas. The circular kivas do not form a part of the house mass, being separated some distance from the

*Both kinds of circular kivas are found in the cliff-ruins at Casa Blanka and in Mummy cave in the Canyon de Chelly.

secular rooms. From all that can be learned it appears that the round kiva is an ancient type, its position in the rear of the cave in such cliff-dwellings as Spruce-tree House and Cliff Palace indicating that this form is as old as the building itself. The circular type with pilasters, is confined wholly to the eastern region,* having been reported from the Mesa Verde, the San Juan and many of its tributaries, Chaco canyon, and certain ruins west of the Rio Grande. Circular kivas somewhat modified are found also in many of the Rio Grande pueblos, where they are still used. A subtype of circular kivas without the pilasters but provided with one large banquette is the common form of circular ceremonial room in the Navajo National Monument and the Canyon de Chelly. The modern representative of this subtype is the Snake kiva of the Hopi, which has become rectangular, the large banquette (tuwibi . . . .) being modified into the 'spectators'.

"The corresponding ceremonial rooms at Zuni and in the prehistoric Hopi pueblo are rectangular in form and of simple architecture. Similarly shaped ceremonial rooms, not subterranean, are still in use in modern Hopi pueblos. As a good example of this archiac form of ceremonial rooms at Walpi may be mentioned that in which the Flute altar is erected and in which the Flute secret rites are performed.** This ancestral room of the clan is a rectangular chamber forming part of the second floor, and is entered from one side. The Flute clans came from a pueblo, now in ruins, in the north, but after union with the Ala, who lived at Tokonabi, they settled at the Snake pueblo, Walpi. So it may be supposed their ancestors also had no special kiva, but celebrated their secret rites in an ordinary house.

"The fraternity of Sun priests likewise erect their altar and perform their secret ceremonies in a room, not in a kiva; so do the Kalektaka, or warriors. None of these rooms is commonly regarded or enumerated as a kiva, but such chambers are believed to be direct representatives of the ceremonial rooms built above ground as a part of the house, in the manner more characteristic of ceremonial rooms in Arizona ruins.

"The ruins in the Navajo Monument (Segi Canyon region) have ceremonial rooms allied on one side to the kivas in the San Juan region, and on the other to rooms in the Little Colorado ruins that may have been built for ceremonial use. The latter are constructed above ground. inclosed by other houses, and are rectangular in shape, with lateral doorways. Some of these rooms, as at Betatakin, contain each fire screen and a fire-hole, as in a circular kiva, the ventilator being replaced by a lateral doorway. It is possible that

*A Kiva in Turkey House in Segi canyon and also in Kaykote canyon at Keyenta are of the six-pilastered type.

**These rites in all the Hopi pueblos are performed, as in ancient times, in rectangular rooms not called kivas The Snake rites are performed now as when the clan lived at Tokonabi in subterranean rooms (k vas), the present form of which is rectangular instead as circular, as at Totonabi."

when the Snake people inhabited their northern homes, before thehy came to Walpi, their ceremonial rooms were not built, as at present, partly underground, and placed at a distance from the secular houses. The ceremonial rooms of this clan and of immediate relatives when living at Tokonabi or in the Navajo Monument (Segi Canyon) region may have resembled those of the Black Falls cluster of ruins* The subterranean position and separation from the other rooms may be regarded as modifications due to foreign influences after the clan arrived at Walpi.

"The sunken or subterranean situation of the ceremonial assembly room or kiva, of the pubelo region is an architectural survival of a people whose secular and ceremonial rooms were subterranean.** This feature may not be autochthonous in this area, or limited to it geographically, having probably been derived from people of kindred culture of the west coast, as pointed out by Mr. Ernest Sarfert's argument on this point, which would seem to be conclusive if subterranean kivas could be found in the Gila and Little Colorado regions.***

"The forms of pueblo kivas, circular or rectangular, are not derived one from the other, but suggest different geographical origins. The circular form, confined to the eastern Pueblo area, bears evidence of having been derived from the culture of a people inhabiting a forested region; while the recangular form strongly suggests a people of a treeless habitat. Both circular and rectangular subterranean assembly rooms existed in aboriginal California in historic and prehistoric times. The archiac or prehistoric culture of the Pueblo region is closely related to that of the west coast in other particulars, that do not concern the subject of this article.

"When the Snake clans lived at Tokonabi, and the latter at Wukoki (on the Little Colorado), so far as known they had no subterranean rooms isolated from the others for ceremonial purposes, but used rooms so closely resembling other apartments that they may be called 'living rooms'. Even when they came to the Hopi mesas they may not have had at first a specialized ceremonial chamber. A study of Arizona ruins reveals no rooms identified as ceremonial that are isolated from the house masses. This is true of the ciffdwellings and pueblos, and it is probable that the differentiation and separation of kivas from secular houses, found in modern Hopi pueblos, are an introduced feature of comparatively late date. At Zuni a rectangular room, not separated from the house mass, serves as a kiva, the custom in this respect approaching more closely that found among their kindred, the ancient people of the Little Colorado river, than among the more modified Hopi of the present time.

*"It appears that in some of the ruins of the Navajo National Monument there were both circular subterranean kivas and rectangular rooms used for ceremonial purposes. At Wukoki the former do not exist but two of the latter can be recognized, one of which has a construction like a ventilator.

**"None of the five Walpi kivas is older than 1680, and one or two are of later construction."

***Hans und Dorf bie den Eingeborenen Nordamerikas, in Arch. fur Anthr. N. F. Bd. vii, Heft 2 and 3.

"While some of the rooms identified as ceremonial in preceeding pages are rectangular in shape and not isolated from secular rooms, the circular type seems to have been found in Utah, and at Kitsiel (Keetseel) and ruins near it. South of Marsh pass circular kivas are less abundant, and it appears that somewhere in this region is a line of demarkation between ruins with circular kivas and those with rectangular kivas. In prehistoric ruins from Marsh pass southward to the Gila valley no rooms have ever been identified as kivas, al- through the cavate ruins called Old Caves, near Flagstaff, are subterranean rooms entered from the floor of the room above, which may have served for the performance of religious rites.

"From a comparison of some features of the kiva in the cliff-dwellings of the San Juan and its tributaries with those of the Navajo National Monument it would appear that while the ceremonial rooms of the latter in certain details are like those of the former, in some cases their form and position are different. So far as this resemblance goes, it may be reasoned that the San Juan ancients influenced by their culture the northern Arizona cliff-dwellers, but there is scant evidence of the reverse, that is, that the San Juan pueblo borrowed from the culture of the northern Arizonians any architectural features, especially in the form and construction of their kivas. The theory would be logical that the prehistoric migration of culture was down rather than up the river, and the symbolism of the pottery contributes interesting data supporting this conclusion."

The pottery, as we have seen, readily divides itself into two series one approaching the ancient Tusayan type (though remotely so), the other the Zunian type just prior to the coming of the Spaniards.

The Tusayan type of village here is not very different from the numerous ruins in the Hopi country, and probably represents an eastward migration of those people at some remote time; they may even prove to be the ruins of an earlier Zunian migration. The Zunian type of ruins, however, is peculiar to the region, differing in some respects from any ruins previously described. The ruins are mostly circular or D-shaped; but instead of being built around a kiva as a center, as the circular and D-shaped ruins in southwest Colorado and southeast Utah are built, the most of them are built around a central plaza. And again, they combine the "great house" and "tower" of the McElmo, Cannonball, Montezuma, and Yellow-jacket canyons of Colorado and Utah with their structures. Moreover, the D-shaped ruins have the straight side of the "D" on the west or northwest here and in the Colorado region they are on the south or southwest side, and are also found to be so constructed in the Kayenta country. In this region the straight side of the "D", or the round side that corresponds to it in the circular ruins, was built of stone where stone was at all available, the rest of the village being built of adobe or wickerwork plastered over, or was just a camp site without buildings. A few ruins in the Kayenta country were similarly built; but no exactly similar ruin is described elsewhere though ruins of a somewhat similar type are described in Colorado, as will be mentioned later.

The straight side of the "D" was of stone and was probably 4 or more stories high, corresponding very much to the "great houses" and "towers" to the northward, but differing from them, they all formed the west, northwest, or north side of the plaza of the D-shaped or circular village. Their position would seem to place them as windbreaks against the fierce winds of winter, and also to serve as ceremonial rooms, observation towers, lookouts, the "strong-house", and possibly storeroom of the place. The scanty pottery about each one and the abundance about the rest of the village seem to bear out this conclusion. It has been suggested that the straight side of the "D" was always on the main valley or mesa-front side, but the writer has not found it so. It has also been suggested that the D-villages in Colorado faced the ancient home somewhere in the Utah-Colorado country and that here face the Zunian home. This is mere conjecture based on no known facts. The villages are a combination of the "great houses" and the D-shaped ruins of the Colorado-Utah area combined in one structure, with the loop-side of the "D" on the southeast, east, or south side, instead of on the opposite side as in that region.

It might be added here that no ruin in this region has ever been excavated, at least with findings recorded. Consequently, what the earth-mound part of the circle or "D" of these villages may have buried within it is only conjecture. Some have suggested that this mound is simply the rubbish pile of the stone village; but in most cases it seems too large to have been thus exclusively formed, the mound containing more material in bulk than that of the stone edifice itself. If it should prove to be such, we must conclude that the villagers must have lived here a very, very long time. Furthermore, if the mound was simply a rubbish mound, it would be composed mostly of ashes; but the few cross-sections the writer has made do not indicate a sufficient quantity of such material to justify such a conclusion. On the other hand, excavation has shown that burials were made beneath these heaps. Large amounts of calcined stone also show which were evidently used in the cooking process and also probably in the sweat bath ceremonies. The writer's cross-sectioning also showed no signs of walls of any kind, though there some villages which show stone foundations of buildings in this section. The writer must conclude, as he has previously intimated, that these earth mounds were the resident part of the village, at least in good weather. From observations so far made they seem to have been composed of open air quarters and adobe and lattice-wickerwork plastered-over rooms probably of a more or less temporary nature, as well as the dumping place and burial ground.

It might be added that it is hoped that before another year there will be enough excavation-work done in the region to clear up this subject, the request for permission to do excavation work is now pending through the good offices of the Kansas Academy of Science.

Dr. Fewkes describes somewhat similar ruins in Colorado under the heads "Circular Ruins with Peripheral Compartments", and

"Great Houses and Towers", though a difference between the ruins he describes and those here can be readily seen. Below is appended his findings, (13:pp. 31, 33, 40, 42, 43, and 44) as follows:

"Circular Ruins with Peripheral Compartments

"It has long been recognized that circular ruins in the southwest differ from rectangular ruins, not only in shape but also in structural features, as to relative position and character of kivas. The relation of the ceremonial chambers to the houses, no less than the external form of the two, at first sight, appear to separate them from the pure type. They are more numerous and probably more ancient, as their relative abundance implies.

"These circular ruins, in which group is included certain modifications where the curve of one side is replaced (generally on the south) by a straight wall or cord, having several concentric walls; again, they take the form of simple towers with one row of encircling compartments, or they have a double wall with inclosed compartments.

"Many representatives of semicircular ruins were found in the region (southwestern Colorado) here considered, some of which are of considerable size. The simplest form is well illustrated by the D-shaped building, Horseshoe House, in Hackberry Canyon, a ruin which will be considered later in this article. Other examples occur in the Yellow Jacket, and there are several others as Butte Ruin, Emerson, and Escalante Ruins, in the neighborhood of Dolores.

"In contrast to the rectangular village type consisting of a number of pueblos clustered together, but separated from each other, where growth takes place mainly through the union of compartments, the circular ruin in enlarging its size apparently did so by the addition of new compartments peripherally or like additional rings in exogenous trees. Judging from their frequency, the center of distribution of the circular type lies somewhere in the San Juan culture area. This type does not appear in the Gila valley or its tributaries, where we have an architectural zone denoting that a people somewhat different in culture from the Pueblos exists, but occurs throughout the "Central Zone", so-called, extending across New Mexico from Colorado as far south as Zuni. Many additional observations remain to be made before we can adequately define the group known as the circular type and the extent of the area over which it is distributed."

Emerson Ruin

As a type ruin, the Emerson ruin is here given according to Dr. Fewkes:

"This ruin crowns a low hill about 3 miles south of Dolores. The form of the mound is semicircular with a depression in the middle around which can be traced radiating partitions suggesting compartments. Its outer wall on the south side, as in many other examples of this type, has fallen, and the indications are that here the wall was straight, or like that on the south side of Horseshoe Ruin."

"GREAT HOUSES AND TOWERS

"Great houses and towers differ from pueblos of the pure type but may often be combined with them, forming composite houses arranged in clusters called villages. Castles and towers may be isolated structures without additional chambers, or may have many annexed rooms which are rectangular, round, or semicular in form . . . . .

"Structure of Towers.

"While the author has found no ruin of the same ground plan as Sun Temple on the Mesa Verde, D-shaped towers or great houses from several localities distinctly recall this mysterious building, and there may be an identity in use between Sun Temple and the massive-walled structures of the McElmo and Yellow Jacket; what that use was has not thus far been determined. If they were constructed for observatories we can not account of the square tower in the South Fork of Square Tower Canyon, from which one cannot even look down the canyon, much less in other directions, hemmed in as it is by cliffs. Isolated towers are often too small for defense; and they show no signs of habitation.

"Are they granaries for storage of corn or places for rites and ceremonies? Do they combine several functions—observation, defense, and storage of food? Thus far in studies of more than 30 towers and great houses not one has been found so well preserved that enough remains to determine its use, and yet their walls are among the best in the southwest ruins. . . . . .

"No writer on the prehistoric towers of Colorado and Utah has emphasized the fact that a large number of these buildings are semicirular or D-shaped, but it has been taken for granted that the fallen wall on the south side was curved, rendering the tower circular or oval. In most cases this wall was the straight side of a D-shaped tower. Dr. Prudden, who first recognized the importance of a union of towers with other types of architecture in the McElmo district, says: 'Towers of various forms and heights occasionally form a part of composite ruins of various types.' He says also: 'Several of the houses are modified by the introduction of a round tower.' And again: 'At the head of a short canyon north of the Alkali, which I have called Jackson Canyon . . . . . each building consists of an irregular mass of rooms about 200 feet long, with low towers among them.'

"Several towers have accompanying circular depressions with surrounding mounds. This association can well be seen in Holmes Tower on the Mancos Canyon and in Davis tower and one or two others on the Yellow Jacket. These depressions, sometimes called reservoirs, have never been excavated, but from what is known of rooms accompanying towers in the western section of Hovenweep Castle it may be that they indicate kivas. Some towers have no sunken area in the immediate vicinity, especially those mounted on rocky points or perched on boulders. At Cannonball Ruin there are several kivas side by side in one section and towering above them is a massive walled tower and other rooms."

The last above are the only villages that are almost exactly similar to the ruins here, a tower-section accompanied by a depression (plaza) with surrounding mounds, and Dr. Fewkes does not say that any of these towers and circular depressions with surrounding mounds are D-shaped as practically all are here.

The writer's conclusion is that the Zuni clans originated in Colorado or Utah and migrated southward to Zuni, leaving the peculiar D-shaped and circular ruins behind them as they migrated, the more recent ruins being those left by the same peoples on one or more of their northward migrations from Zuni. A study of the open ruins from the top of the Chinle-wash-divide 6 miles northeast of Ganado to McElmo canyon in Colorado through a natural gap of open country, would undoubtedly throw some light on the subject. The more recent ruins here, as previously mentioned, probably belong to a recent migration of the Zuni, as both the traditions of the Navajo and Zuni assert.

Whether the Tusayan peoples were driven out by nomadic tribes or by the Zuni, or whether they became incorporated with the latter, can not be determined with the data at hand. A Navajo tradition has it that they were all one people and that after wars among themselves and with the Athapascans they separated, one part going to Hopi and the other to Zuni. The last comers, the Zuni gentes, seemed to have no enemies in the region for a long period of time, as they scattered in small villages which would have offered but little resistance to a formidable enemy. This conclusion is borne out by the fact that the D-shaped villages were built anywhere where suitable rock could be obtained to build the "great house" part of the structure. Moreover, high points and promonitories that could have been easily defended were usually not used as village sites by this people, as in other sections of the Navajo country. Then there came troubled times, and they seem to have been swift in their coming. To meet the emergency villages were built to hold the springs, and the tower-village at Sunrise Springs was hurriedly constructed, an older village on the same site being torn down to construct the edifice. The large circular ruin of Kintiel, 25 miles to the southward, Hogay Ruin at Steamboat, and the large circular ruin at Eighteen Mile spring, were probably erected at about the same time. Also at about the same time Ruin A at Cornfields was hurriedly built, being added to as clan after clan sought that location and its walls for protection, as can be seen by the ground plan. Then the region was abandoned, the latter ruin showing by the scantiness of its pottery fragments and its small graveyard and refuse heaps that it was occupied only for a short time. Since then the walls of the ruin have crumbled to long heaps of rocks, waiting the coming of the excavator and archaeologist.

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The work of the year 1924 was in the Cornfields-Ganado region, as was the greater part of the work last year. It covered a larger area there, it also verified former conclusions.

It might also be added here that the earth mound east of the stone structure of the ruins of this region (in some cases surrounding the stone structure) is the so-called "ash-heap" of most writers, others calling it the "refuse heap". The stone structures, in the main, are rectangular, and the villages were the homes of a "small house" people, though ruins A, 64, 99 (Hogay), 45 (Sunrise Springs, Tower Ruin), Kintiel, and Klagitoh, were large villages. Upon the refuse heap were thrown the ashes and discarded things, and the bodies of the dead were often buried in it. Their slogan seemed to be—"The body to the refuse heap, the spirit to Sipophe with the ancients." (Hewett); but the findings in this region as well as in the Tuba-Kayenta region is that many of these refuse heaps were also camping sites, or contained summer structures of lattice work, which time has removed.

Below is a description of the ruins examined in 1923 (the numbers beginning where they were left off last year):

Nos. 122 and 123. These are circular-D ruins, now in a field east of Pueblo Colorado wash between Ganado and ruin No. 26. They are now leveled and plowed over. The pottery is that of the D-type. A small jar was obtained from No. 123, having been dragged out by harrowing.

No. 124. This is a small D-shaped ruin in the flat 2 miles southeast of Sunrise Springs, southeast of ruins Nos. 45 and 46.

Nos. 125 and 127. These are small D-shaped ruins on the mesa about east of Sunrise Springs, a mile or so inland.

Nos. 127 to 129. These three ruins lie southwest of ruins Nos. 48 and 49 on a lower bench of the same ridge on which the latter are situated. They were all D-shaped and about of the average size of the "small house" ruins of the region.

No. 128M. In the flats in the sand dune swept area about halfway between Mr. Black's store at Cornfields and Sunrise Springs, between the main road south of Pueblo Colorado wash and the wash, the wind is exposing much pottery and some rock over quite an area. The size of the village represented is unknown.

No. 129N. In the same flats, one mile southeast of ruin No. 128M there is a small D-shaped ruin.

No. 130. About 3 miles southeast of ruin No. 129N and a half mile north of Smiler Brothers' hogan, there is a D-shaped ruin of considerable size, but only a little pottery is shown.

No. 131. This is a D-shaped ruin upon the up-flats about 2 miles nearly south of ruin No. 130. It was of medium size, of the "small house" type, and shows but little pottery.

No. 132. This is a small ruin about a mile and a half northeast of ruin No. 131. It commanded a ridge.

No. 133. East of the road east of Pueblo Colorado wash and east of the big bend in that wash about half way between Cornfields and Ganado, there is a high isolated mesa. On its top there are some scattered potsherds and indications of a few rock walls, but not enough to tell the size and shape of the village, except that it was small, probably a watch tower. Since the mesa is adjacent to farm lands along the wash and would have been a good location for a fortified village, one is surprised to find such a small structure on its top.

No. 134. About one and one-half miles northeast of the isolated mesa mentioned under ruin No. 133, one encounters the north end of an almost north-south ridge of the "C" division of the Chinle formation. The formation is here capped with cherty limestone and its strata dip about 10 degrees west of south. The wash has cut a gap through this ridge and it is again exposed north of the wash. Just north of the ridge south of the wash there are some low mounds, and on three of these there are remains of ancient altars in piles of stone and petrified wood. The middle mound also shows that a small village once occupied its top, but the size and shape of this village could not be ascertained. Much broken pottery is now scattered about this site.

No. 135. Around the above mentioned ridge one-fourth of a mile east of ruin No. 134, there is a small village of the D-shaped type. It is situated between the ridge and a deep wash which it abuts. The wash did not exist at the time the village was occupied; but the flood waters which now course down it were evidently used by the villagers for farming. The village was made of cherty limestone, and though it was small, it now makes a conspicuous pile. The pottery, though large in size, is scanty, mostly showing in the walls of the wash and on its slopes.

Northeast of an arroya one-half mile northeast of ruin No. 135, much pottery and some rock is being exposed by the shifting of the sand by the wind. No house foundations were seen, and as the formation is piled sand, the pottery and rock probably represent ancient graves. The pottery is of large fragments.

Ruins Nos. 136 to 155 are on bluffs (edge of the mesa) overlooking Pueblo Colorado wash from the east, east and southeast of Sunrise Springs.

Ruins. Nos. 136 to 144 are on the same segment of the mesa as the Tower Ruin (ruin No. 45) at Sunrise Springs to the northeast of that ruin; and ruins Nos. 145 to 155 are on an adjacent mesa southwest of that ruin, southwest of an easterly ascending canyada of Pueblo Colorado wash. The lands farmed by these Indians were in the flats about Pueblo Colorado wash, and their water supply for village use was undoubtedly obtained from the same source and possibly from shallow wells. The water in the inner flats of that wash is now within 6 feet of the surface and thousands of sheep are now watered from shallow wells there.

The ruins all seem to belong to the same series as the Sunrise

Springs (Tower) ruin and are approximately of the same age.

No. 136. On the west edge of the bluff east of the flats east of Pueblo Colorado wash 3 miles due south of Mr. Black's store at Cornfields and the post office there, there is a ruin 17 paces long which also shows an ash-heap mound. The pottery is scanty.

No. 137. A very small ruin is located 150 feet southwest of ruin No. 136. It probably contained only a room. The sherds about this site are scarce. Some chipped flint shows.

No. 138. This ruin is 100 feet southwest of ruin No. 137. It is 14 paces long and has a large refuse heap forming the "loop" of the D. Considerable broken pottery and some arrow heads mark the site.

No. 139. This is a ruin one-fourth of a mile southwest of ruin No. 138. It has a small refuse heap, a few sherds and some arrow heads were found. The stone mound is high. The place was evidently not occupied long.

No. 140. This ruin is one-fourth of a mile southwest from ruin No. 139. The walls of the building show in part of the ruin. Potsherds are scanty about the site.

No. 141. This ruin is 400 yards southwest of ruin No. 140. It is situated on a mesa tongue which projects toward the northeast. It is 14 paces long. A very slight earth mound shows east of it. The pottery is scanty.

No. 142. This ruin is 350 yards nearly south of ruin No. 141. It is D-shaped. Its conspicuous stone mound is 14 paces long, 6 paces wide, and 12 feet high. This mound is somewhat half-moon shaped. The plaza depression is large and 3 feet deep. The circumference of the village is 43 paces. Much pottery, some bearing new patterns, covers the site. The village was evidently occupied for a long time.

No. 143. This ruin is on a projecting mesa-tongue, one-fourth of a mile due west of ruin No. 142. The stone mound is conspicuous. Considerable pottery marks the site, which indicates that it was probably occupied a long time.

No. 144. This ruin is about one-fourth of a mile west of ruin No. 143. It is the ruin of a small village, as was seen from a distance.

No. 145. This ruin is on the mesa-bench on the bluff east of Pueblo Colorado wash, about a mile east of Sunrise Springs store, and probably three-fourths of a mile southwest of the Tower Ruin (Ruin No. 45). It was composed of a series of buildings. Much pottery marks the site, which was probably occupied for a considerable time.

No. 146. This ruin is about 380 yards across a canyada about due south of ruin No. 145. It is more or less D-shaped. It was occupied for a long time, judging from its numerous broken pottery fragments.

Nos. 147 and 148. On higher ground some 400 yards to the eastward of ruin No. 146, commanding a ridge, there are two ruins that have been reduced to level, probably being very old. The north ruin still shows the D-shape, though only few stones show about it. Many pottery sherds, however, mark the site of each.

No. 149. On a promontory about one-half mile southwest of ruin No. 146 there are the remains of a very large village. The rock pile is now in new moon shape, facing east. The refuse heap, though

subjected to much weathering and stock-tramping, is also large. Much pottery marks the site on all sides of the stone village mound.

No. 150. This is a small ruin in the flat, 500 yards east of ruin No. 149. Quite a plaza depression shows.

No. 151. This ruin is on a ridge one-fourth of a mile east of ruin No. 150 and on the second ridge inland one-fourth of a mile southeast of ruin No. 146. The village was large and D-shaped, the stone building part now being 18 paces long, 5 paces wide, and 6 feet high. It was long inhabited, as much broken pottery now covers the ash-heap and earth mound. Remains of a small altar also show northwest of the stone heap.

No. 152. Up the same ridge about 50 yards north of ruin No. 151 there is a conspicuous stone mound. East of this mound the refuse heap is small but to the east of the latter there is a conspicuous refuse mound covered with sherds. Some 100 feet south of the stone heap of this village there are remains of a large, older village which has been leveled with time. Considerable pottery, among which is some red ware, shows there.

No. 153. On top of the same ridge, 400 yards north of ruin No. 152, there is a ruin 17 paces long, built in crescent shape. East of it there is a rather large plaza-depression, and just east of this is a circular kiva-depression 16 feet in diameter. An earth mound shows to the east and southeast of the plaza-depression. There are also indications that other and more ancient villages once occupied this ridge.

No. 154. This is a long ruin, or series of ruins, about 100 yards north of ruin No. 153. East of the north group of this series, east of the plaza-depression, there are a large earth mound, the refuse pile, etc. This ruin seems much older than ruin No. 153.

No. 155. This ruin is 150 feet north of ruin No. 154. It is small, is on the same ridge, and appears very old.

No. 156. This ruin is southeast of an unnamed volcanic mesa 3 miles northeast of Indian Wells (Biddahoochee). It was small and though volcanic rock was abundant it appears to have been built of adobe. It is represented principally by pottery fragments which encircle the site.

No. 156 1-2. This ruin is one-fourth of a mile across a hollow, northeast of ruin No. 10. It was small. Few sherds were scattered about the site, mostly black and corrugated ware. The village had evidently been used only as an outpost station.

No. 157. This ruin is 5 miles northeast of White Cone store on the east edge of the present Hopi country. It is in a canyon to the north of the Keams Canyon road about a quarter of a mile up the canyon, as the road ascends from the flats to the top of the Tertiary mesa towards Keams Canyon (Moqui) Agency station from Holbrook. The village was evidently small and was either built of adobe or of Tertiary sandstone which has disintegrated. The scattered pottery now covers quite an area. The size and shape of the village can not now be determined.

No. 158. This is a ruin around the point of the mesa east of the Keams Canyon road, one-half mile southeast of ruin No. 157. It is now represented principally by broken pottery and cobbles. Its size and shape is now indeterminable.

This ruin and ruin No. 157 evidently guarded the pass where the Keams Canyon road now ascends the mesa from the flats to the southward.

Ruins No. 159 and 160. These two ruins occupy the southeast point of the mesa that separates Steamboat (Murphy) Wash and its northeastern tributary at their junction. This tributary drains the region where the artificial lake is situated 5 miles west of Cornfields. The mesa is here capped with volcanic rock and interstratified tuffs and sand rock of Tertiary age, these being superimposed on what appears to be McElmo rocks. At the point of the mesa there appears to be a denuded core of one of the Tertiary craters that played such a part in those remote times.

The two washes are wide and flat-bottomed here and in them even now the freshet waters spread out all over their inner valleys. Only 3 miles below these sites the Navajos now raise large crops of corn, melons, and beans, by means of a flood-irrigation system—dry farming plus the spread-out flood waters in the rainy season, the same system that is now used in the Hopi country. However, the Navajo is too lazy to make it as successful as the Hopi now do, or as the ancient villagers did. Except in the rainy season both of these streams are dry washes, and the indications are that they were thus in the days of the villagers. The country in the vicinity was not searched for springs, but such probably exist and did exist in former times.

Ruin No. 159 is in four sections, each section being built in rectangular form. Ruin 160 combines both the rectangular and the D-shaped forms, with much scattered debris. Only one section of this ruin shows a high stone mound. The rest is more or less leveled. The scattered rock, however, seems to indicate that stone structures occupied all the sections.

Neither village shows an ash heap, earth mound, or graveyard site that can be detected without extensive search. The pottery of both villages is different from any yet seen by the writer, except at just a few sites. No corrugated ware was found about village No. 159 and only two crudely made potsherds of this type were found about site 160. The other kinds of pottery are not plentiful, consisting principally of a crude, thin, coarse, practically unslipped gray ware with spare and crude decorations, sometimes resembling bird-tracks. No red ware was seen about these sites.

The pottery would seem to indicate either a beginning stage of culture or a breaking down of a pueblo culture just at the vanishing stage. A find at ruin No. 159, a drawing on a slab of tuff of what was at first supposed to be a horse, was thought to point to a late state. No other such piece of tuff was near the site, and the piece found was lying among a lot of broken pottery fragments. Should

this drawing be that of a horse, it would indicate that these villages were occupied since the introduction of horses in the region.

It is an established fact that the Asa people went from the Hopi country to Canyon DeChelley and built many of the cliff houses there. There they lost their language, and their women were taken in marriage by the Navajos; but a quarrel with the latter caused them to return to Hano of the Hopis, their former home, which they found occupied by Tewa peoples, probably between 1700 and 1710. These Tewa were Indians who had fled from the Rio Grande during the troubled imes of 1680-1705 and had been given homes by the Hopis. So the generous Hopis took in the Asa people at Walpi. They also gave them a strip of ground on the east edge of the mesa where they afterwards constructed dwellings, but at a later time a number of them removed with some of the Lizard and Bear people to Sichumovi. (Consult Fewkes, 11:vol. 1, pp. 99-100.)

The natural route from the Hopi country to Canyon DeChelley would be up through Steamboat Wash-gap, past Steamboat and on through Chinle wash to Canyon DeChelley, as it is a valley all the way. And if these villages should prove to be "late sites" they were probably built as these people were journeying, either in going to Canyon DeChelley or on their return, apparently on the latter trip, as it would seem that their art of pottery making had almost dropped to the level of the Navajo type. The horse drawing, if it proves to be such, shows that they were familiar with that beast, as the drawing, though crude, seems to fairly well represent that animal, even showing his hairy tail outstretched, as the "horse" is depicted in running. The drawing also seems to represent the "horse" in the wild state.

An analysis of the pottery and a close comparison of it with other pottery of the southwest shows it to be of the slab-house type, as are the black and white designs on the same. A more careful examination of the drawing also seems to indicate that the beast has horns, crudely represented, and that the figure is that of a running antelope instead of a horse. The pottery would definitely place these ruins as to age in the slab-house stage of culture.

Ruins No. 161 to 163, or Salina (Standing-up-sharp-rocks-points) Springs ruins. Between the north hump of Salahkai mesa and Sohali Point there is a line of white (McElmo) buttes, capped partly with a Dakota cap. There are five of those prominent buttes, and numerous jutting spires and cone-shaped points, standing from 100 to 300 feet above the plain, and though small in area on top, they make conspicuous land marks. The country about these buttes is a McElmo rock region of poor soil; but to the west of the buttes, between them and Black Mesa, and in the canyons to the northwest there are extensive flats with good land that could be utilized for dry farming and flood water irrigation, some being now so farmed by the Navajos. At Salina (Navajo Tsalonnee—tsea, rock; lonnee, standing-up-pointed) there are numerous seeps and springs. And on Salakai mesa adjacent there are several large springs.

On asking if there were ruins in the region, the writer was informed that none had been seen, except a fort on a rock-butte just south of Theater rock, and the writer's investigations in the region on July 4th (1923) failed to locate more than one other village of any size though there are undoubtedly other villages in the section. An Indian also stated that near his place there were a village and a graveyard, many skeletons being exposed at the latter place, but time would not permit the writer to visit this site. On the whole, however, the ancient villages appear to be scarce, which seems to indicate that there was no more water in the region in the time of the villagers than now. Otherwise, as villages could have been built in strong, naturally fortified places, the country here would have been covered with villages in that far off time, as are other similarly located vales in the Navajo country.

No. 161. This is the fort village on the second mesa-butte northeast of Salina Springs store. The mesa is irregular in shape and 250 feet in perpendicular height with vertical walls, except at one point on the north face where ascent is made over a rough trail to its top as it was in the days of the ancients. Surrounding the head of this trail the fort village was built, which with walls and guards along its broken section and piles of rock to be sued as Indian artillery, must have made the place impregnable.

On the whole, a practically continuous village line shows in an almost northeast-southwest line for 83 paces, with extensions running east and southeast. The village was of rock and now makes a conspicuous pile. Southeast of the village and also in the plaza there are remains of refuse heaps, which are most extensive about the east section of the village. This would seem to indicate that this section was inhabited longest, if not also the last. There are scattered buildings about the site, and pottery fragments on the point of the mesa 300 yards south of the village, which seems to show that there was a watch tower there.

No. 162. This village ruin is on the east edge of a low McElmo mesa in the flats about a mile west of ruin No. 161. Its stone part, now a heap, is 22 paces in length and has a half moon shape. Its refuse pile has been mostly carried away, but the numerous broken pottery fragments show that the village was long occupied.

No. 163. A small ruin was found on a bench just west of ruin No. 161. Its size can not now be determined.

Note on the Salina Ruins: The pottery of these ruins show an admixture of Kayenta designs with patterns of the Cornfields section, as well as patterns quite dissimilar to those of those regions. The shape and paste of the pots also seem to indicate the coming of peoples from some other section.The writer, however, did not have time to investigate this thoroughly.

No. 164. On the mesa flat at the head of a side wash extending south-southeast about 5 miles of Cornfield's store, a series of peculiar ruins was found. Four depressions extended in a broken line along a slight rise on the mesa in a line one-half mile in length. Three

other similar depressions were also seen to the southwest on the same flat. Around the head of a little canyon and its breaks much pottery was found scattered about, and one-fourth of a mile to the northwest another depression was observed. These depressions were each some 16 feet or less in diameter. The pottery about them was scanty and practically all of it was corrugated ware. The southeast two depressions were close to each other and not far from a small village that had been partly built of rock. These depressions could not have been kivas for so small a village, besides several of them were distant from it. They could not have been resevoirs, as there would have been but little water to store in their location. In many respects they resemble the pit dwellings of the Upper San Francisco River (14) and those of the Pagosa Piedra region, Colorado. (15) More investigation will be needed to determine their status.

No. 165. .One-half mile nearly west of the stone village mentioned under ruin No. 164 above, there is a medium sized ruin of the D-type, including the refuse ash heap. Its stone building was 24 paces long, and there are indications that there were also isolated buildings adjacent. Much pottery marks this site, most of which is corrugated ware of crude type.

No. 166. This ruin is on the west bank of Pueblo Colorado wash, one-half mile northwest of Carrigan's store at Ganado. One corrugated piece of pottery and several gray, unslipped pieces and scattered cobbles mark the site of this ruin that is now nearly washed away. No painted ware was found about the site.

On a flat west of this ruin there are scattered potsherds, and on a little knoll nearby there are indications that there once was a village, which is now almost obliterated.

No. 167. This ruin is on a sand dune on the northwest slope of an isolated Chinle mesa, east of and near Pueblo Colorado wash and near the big bend in that creek about a mile due west of ruin No. A3, west of the line of Navajo hogans west of the Cornfields-Ganado road. It is composed of two nearly parallel rows of mounds of Chinle limestone, each about 70 feet in length. No rooms and no general refuse mounds now show. Potsherds are scattered all abut the site and over a wide area surrounding it. A much decomposed human skeleton was found east of the ruin and that of a buried dog to the north of it. The village must have contained 100 inhabitants and was long inhabited.

No. 168. This ruin is northeast of the Cornfields-Cross-Canyon road. It is on top of the hill northeast of Sabite wash at the bend in that creek 7 miles north of east of Cornfields Day School. It is a small house ruin in D-shape, including its refuse-camp mound. Probably 25 people lived there a long time, the refuse material being now scattered over a large area. One characteristic piece of pottery of the key-step style is exactly like pieces found at ruin A and ruins 71 and 146 of the Zuni sites. Some of the pottery, especially that of the corrugated ware, however, seemed to be quite crude.

No. 169. (Klegitoh, earth-water ruin.) This ruin is situated just east of the Klegi-toh Indian trading store, owned by Nils Hogner, about half way between Wide Ruin and Cornfields post office. It is circular-horseshoe shape, with foundations of what appears to have been a low retaining wall of defense on the east, the other parts being massive piles of fallen rooms. It was built on a side hill facing the east so that it had a terraced appearance. It was also so built that its east wall abuts an east-running arroyo opposite a large spring, 100 feet below which there is another spring. The Navajos say a large depression, 20 feet in diameter south of the ruin, was once a spring, but is now dried up. It, however, has more the appearance of a large kiva depression. Another somewhat similar depression abuts the village wall at the south. Three kiva depressions and parts of several large rooms show within the ruin inclosure.

In excavating for the store three skeletons were found, along with which were several corrugated jars, but no painted ware, Mr. Hogner informed the writer. The writer saw part of an exposed skeleton near the north side of the ruin, and one just outside of it on the south.

The rooms of the village circle were small, as is shown by the ground-plan mound-formation, which can still be traced, one room being only a step in length.

Much debris is scattered as refuse heaps south, west and southwest of the village, but the amount is small in comparison with the size of the village, which seems to indicate that it was not inhabited long. The scarcity of pottery fragments also bears out this conclusion.

The village was built in this location to command the water of the springs and was undoubtedly built in its fort-shape for defense. It had the flats of Wide Ruin wash to the southward for farm lands, being thus very favorably located. Probably 500 people inhabited this village at the height of its power.

The building rock for the store and the present retaining walls for the two springs have been taken from the rock of the village mound. Some excavation work seems also to have been done about the site.

Kintiel or Wide (Broad) Ruin. This ruin was excavated and described by Dr. Fewkes, to whose work the reader is referred. (8:pp. 124-134))

Several kiva depressions show within the inclosure. Several circular depressions also show without the walls, which were probably also kivas, one especially noted about half way between the altar and barn, none of which were mentioned by Dr. Fewkes.

The writer's visit to the ruin was for the purpose of obtaining sherds and he was surprised to find so few on the surface considering the size of the ruin. Only a few characteristic sherds were found in hours of diligent search by the writer and his wife. The refuse heaps were also found to be small for so large a village. Certainly a village of its size with so few sherds and such small refuse heaps was not inhabited long, unless the refuse was dumped in the cañyada bed that runs through the center of the village and was carried out by it in freshet times. For a detailed account of this ruin see Dr. Fewkes above.

Fig. 3. RUINS AT KINNA ZINDE.

Kinna Zinde. This ruin was visited August 5th, 1923. It is a long building, one end of which is round, the remainder being rectangular. It is perched upon a rocky ledge adjacent to a mesa on one side and overlooking broad flats on the other. It is still in a good state of preservation, parts of two stories still remaining. It is essentially a tower like those in McElmo and adjacent canyons in Colorado and Utah.

The building was constructed of DuChelley sandstone which is exposed in a wash a half mile northeast. One-fourth of a mile northeast of this ruin just east of the road there is a heap of rock in which a square room shows.

Like Dr. Fewkes, who also visited this ruin when examining Wide Ruin, the writer was struck with the scarcity of pottery fragments and other refuse about the site. Dr. Fewkes concluded that this village was a summer farm home, peopled by farmers from Kintiel, but the numerous light buff potsherds would seem to indicate that it was of later age than Kintiel.

For a complete description of this ruin, see Dr. Fewkes above, p. 134.

No. 170. This is a ruin on top of the hill (mesa) one-fourth of a mile above (north of) Mr. Bob Mahan's house at Kinna Zinde. It consists of four segregations of house-rooms extending in a north and south direction just east of the road for a distance of 400 yards. The building sections were rectangular in shape. Opposite (east of) them there are refuse piles, giving each segment a D-shape appearance. The refuse pile opposite the north rectangular block was much larger than the others or was occupied later so that it has suffered less by time. Much excavation work has been done in the refuse heaps. Diligent search failed to find many characteristic potsherds about the village site.

No. 171. This ruin is about 8 miles northwest of Cornfields. It is over the mesa at the white cliffs about 6 miles nearly west of ruin No. 74. It was found by Mr. Paul E. Gradall and reported to the writer by him. It is wholly leveled, having been probably made of adobe. Its site is now strewn with broken pottery. A small arroya, cutting through the site, has exposed a skeleton lying on its side in an east and west line, with head to the east. A corrugated pot had been placed over the bent knees, and a large food jar and a ceremonial vase had been placed over its head. Above it there had been placed a large flat rock which, sliding down with the canyon cutting, had crushed the jars, parts of which were obtained by Mr. Gradall.

ARCHAEOLOGY OF THE CORNFIELDS-GANADO REGION, ARIZONA, 1925 REPORT

The ruins examined in the year 1925 in addition to those previously reported are ruins 63 1-2 and 192x to 199x.

Ruin 63 1-2 is a small house ruin on the mesa bench near ruins 61-63, 3 1-2 miles east of the government school at Cornfields. It was small but from the numerous sherds one would judge that it was occupied for a considerable time.

Ruin 192x here represents three ruins on an ascending ridge which slopes upward from the flats of Steamboat Wash northwestward toward the top of the Pleistocene (Tertiary) mesa about five miles southwest of Bear Springs ruin (No. 120). The villages were all small, of the regulation small-house type.

Ruin 193x is a cliff ruin on the north side of a canyon south of the Gallup road about two miles west of St. Michaels. Several well preserved rooms show, all of which have been sacked by pot hunters.

Ruin 194x. This represents several ruins in the wooded district between George Mahan's store and St. Michaels, which shortness of time would not permit examining. One of these ruins was of a large village and now makes a conspicuous pile.

Ruin 197x represents a series of ruins on the south side of an eastward leading large wash and at several places near a series of springs and seeps at the head of another eastward-leading wash about six miles northwest of Steamboat store. These ruins, seven in number, are all small except the east two on the first mentioned wash. These two are very large and each shows a large refuse heap and graveyard, together with an enormous amount of scattered sherds. The people of these villages got their permanent water from the same springs that the Navajos now use in the vicinity and evidently farmed the same land that the Indians now farm.

Ruins 198x and 199x are ruins back of Ganado mesa northeast of Ganado and between Ganado and the head of Beautiful Valley. They were both small but show evidence in the pottery fragments that they were inhabited for a considerable time.

The Canyon DeChelly Ruins

Canyon DeChelly trenches the north end of the west slope of the Defiance plateau, beginning in the Luchachukai range and joining the Chinle Wash in the vicinity of the Chinle Indian school in northeast Arizona. This canyon has as its northern branch a wash known as Del Muerto Canyon, so named because, it is alleged, the Spaniards (Mexicans) cornered a bunch of Navajos in it once and killed every one of them. The walls of these canyons are 800 to 1000 or more feet high with a flat floored, very narrow strip between the walls which for most of the year is patchy-green for the greater part of the canyon's course. In the canyon itself there are needles and pillars, the principal one being "The Monument" eighteen miles up the canyon from Chinle, a giant pillar 1035 feet in height.

It is said that there are 1204 ruins in these two canyons; but the writer saw only those which are exposed in the first six miles of the main canyon above the Chinle school, and notes were taken only on the White House ruin situated here.

White House, called chinne-ne a-kli by the Navajos, is a conspicuous cliff ruin, because of its walls being painted white, and, consequently it has been mentioned by every explorer or tourist that has visited the region since Simpson saw it in 1850.

The ruin is composed of two parts as was the original village, a cliff house in a cliff under an overtowering roof of stone and a village built against the cliff wall at its base. The lower part is being cut out by the creek, eight or ten rooms and parts of rooms still remain in this part, the ruins in the cliff house part are still intact practically as Simpson described them in his report.

About half of the kiva in the base village, the half toward the canyon wall, still remains. This kiva had a high banquette, fifty-two inches high, and the kiva above the banquette was still five feet high. The kiva inside the banquette was sixteen and one-half feet in diameter, and the banquette was 28 inches in width, making the upper part of the edifice a little over twenty-one feet in diameter. The roof to this building was made of poles, covered over with straight, small willow poles and brush. Over these were placed small brush, cornhusks and cornstalks, over which mud adobe was spread. The walls were plastered with brown adobe. No ventilator nor pillars show.

The potsherds secured here were quite different from those of the Cornfields district.

Other Ruins

Nos. 200-202. These are ruins up Sabite wash east of the ruins previously described on that wash. They are each composed of a heap of cherty limestone of the capping rock of division B of the Chinle formation. They were rectangular villages of about the medium size of the small house villages.

No. 203. This is a small house village on the bench west of the above wash. It is on the Tertiary bench, and its mound is composed of crumbly Tertiary rock. Many potsherds are scattered about the site.

Ruins 204-206. These ruins are on the bench-edge facing Pueblo Colorado Wash near the Ganado-Indian wells wagon-road just south (west) of that stream. They are near the Indian settlement of Greesewood about twelve miles south of Cornfields, seven miles south of Sunrise Springs, and about nine miles nearly north of the burned Murphy store.

No. 204. This is a series of small mounds on two parallel, gravelly points which project from the mesa northwest into the valley of Pueblo Colorado wash. There are seven mounds on the south ridge and five on the north one. Excavatin proved that they were not burial mounds, and they are too small to have been dwellings. They could have been ovens, but no oven refuse was found in them. Considerable crude pottery was collected about them, which somewhat resembles Navajo pottery but of a cruder make than they use to-day. The writer's conclusion is that the mounds are "ancient" sweat houses of the early Navajos and that the pottery is early Navajo pottery; but his conclusion should be held in abeyance until the sherds can be compared with a collection of very early Navajo pottery.

No. 205. This is a large, practically leveled, ruin, 300 yards southeast of No. 204. Its building, which was rectangular, was 100 yards long. The sunken "plaza" and the refuse heap are both large. Much pottery in sherds marks the site, and probably 200 people lived in the village when it was in the height of its power.

No. 206. This is a small, rectangular ruin 100 yards south of no. 205. While small many potsherds mark the site, which indicates that it must have been occupied a long time.

No. 207. This ruin, which is quite small, is located 2 miles south of Cornfields and was found by the Black boys.

No. 208. (Eagle Rock or Togay Ruin). About 2 miles west of Steamboat store there is a pinnacle known as Eagle (Togay) Rock. It is quite high and is composed of McElmo sandstone. Its top is flat and of considerable area. On this top there is quite a large ruin the ascent to it being by niches cut in the rock face on only one side of the rock pinnacle. Quite a bit of fairly good pottery has been secured from this ruin.

No. 209. (Site 209 of Spier; Notes on Little Colorado Ruins, page 360, also known as Flake's Ruin.) It is a U shaped ruin one and one-fourth miles northwest of Snowflake on the edge of the low land one-fourth of a mile southwest of where Silver Creek boxes in. It has been excavated to a large extent. Sherds about the site are scarce. The ruin is 80 by 70 feet.

No. 210. On the top of the mesa 3 miles due east of Sunrise Springs there is quite a mound arranged in segments. It is 14 paces long in the main mound while several segments are only a little less in length. The refuse mound is low in each case (both opposite the main mound and the segments) and but scanty pottery strews the site. Three Navajo altars have recently been built on the site.

No. 211. Seven miles above the reclamation dam at Ganado, nine miles above Ganado post office, Pueblo Colorado Wash emerges from a practically boxed canyon which is cut in red De Chelly sandstone.

Below this the inner valley of the stream widens out to probably one-half to three-fourths of a mile in width, in a flat strip that is in the neighborhood of five miles in length, the canyon boxing in again before it reaches the Ganado reclamation project. This flat area was a place of extensive farming in the long ago as it is by the Navajos now. The government is now putting in an irrigation dam for the Navajos on this site.

The place where the wash emerges from the canyon is called Kinlechee (Navajo: "kin", pueblo house; "le", a connective particle, and "chee", red, so named because the rock walls of the canyon and the adjacent cliffs are red and the rocks of the village were also red.)

In the long ago when this region was dominated by the village peoples they built the village of Kinlechee at the foot of a scraggy-fronted, small, isolated mesa about one-third of a mile below the mouth of the canyon. Here there was a village section and general graveyard in the flat, the latter being now mostly removed by the encroaching wash. Much of the village section has also been disturbed by the Navajos digging an irrigation ditch through it, along which many parts of skeletons are exposed. A middle section, composed of a U-shaped village, surrounded by detached rooms and much village debris, is exposed on a low bench abutting the mesa, while another section tops the mesa. The top section is composed of a high tower on the southwest surrounding what was probably a kiva, northeast of which there are many low rock mounds of village sections. This part of the village also extends to the top of several isolated crags which were connected by masonry. Several kivas show, as do several depressions which were probably used as resevoirs.

The village was large and held a commanding and defensive position at the head of the flat region that was then a farming section, as now, and the wash furnished the inhabitants water for irrigation and village use then as it does the Navajos now. Probably 500 people lived here.

This village is of interest, for Pueblo Colorado Wash derives its name from it in direct translation, Kinlechee being a direct equivalent of "Pueblo Colorado" in Spanish, and "Red Village" in English.

No. 212. This ruin is known as Pete Springs ruin (Eighteen Mile Ruin of Fewkes and the early writers of the region. (8:p. 127), Camp 100, White Rock Springs of Ives' Report upon the Colorado River of the West, and Keetseel of the Navajos of the immediate vicinity), being situated near Pete Springs, as the name implies. This spring, which was so named because a man by the name of "Pete" chiseled his name in bold letters on the canyon-wall directly above the spring, is known as Peshbitoh (Pipe Springs) by the Navajos; and as Spring No. 199 of Gregory (5:p 155). It is situated in a side canyon northwest of the Keams Canyon-Fort Defiance wagon-auto road, seven miles west of Eagle Crag, nine miles west of Steamboat (Sheep Springs) trading store. The source of the water is contact of strata in Cretaceous sandstone. The spring is now dug out and resevoired, and the water is piped into troughs so that now thousands of sheep

are watered at it every day.

In the long ago this spring furnished water for the ancient peoples and the flat lands adjacent below the side canyon furnished them farming land. To protect this spring and keep it in their possession, they built their fort village on the very edge of the mesa overlooking it so that the spring was commanded by arrow shots from its very walls, the mesa here being 30 feet in perpendicular height above the water of the spring.

The village is circular with outer wall still standing from 7 to 10 feet in height, all made of well laid-up rock which is mortared in with adobe mortar. The wall, which is of heavy make, differs from any other wall seen in the region by the writer, in that no buildings were ever built up to it, nor does it form the part of any building. It is a wall of defense pure and simple. Several feet inside of this wall there is an approximately circular wall to which buildings were joined on its inner side. A large circular building, probably representing a kiva, occupies quite a space within the second wall, and several mounds, probably representing ancient buildings, also are scattered about the central space.

Fig. 4. FIFTEEN MILE RUIN AT PESHBITOH SPRINGS.

(About halfway between Steamboat and Keams Canyon in the Navajo country, Arizona.)

This is Tebungki (Fire House) of Fewkes, also called Beshbito by him, meaning water pipe (Spring) ruin. See Fewkes, J. Waller: Archaeological Investigations in New Mexico, Colorado and Utah, Smithsonian Miscellaneous Collections, vol. 68, No. 1, May, 1917, pp. 2-5. Dr. Fewkes considered that this village was a former home of the clans which afterward settled at the now ruined village of Sikyatki, near the present Hopi village of Walpi where their descendants now reside.

The ruin is 106 paces in circumference and 31 paces in diameter from east to west and 34 paces in diameter from north to south. In appearance it is a fort pure and simple, and the scattered scantiness of the potsherds about the site seem to bear out that conclusion.

The graveyard and dump-heap were among the broken boulders of the talus slope abutting the mesa to the westward down the valley just below the spring. Parts of five skeletons were seen here and it was here that the writer obtained all his sherds from this site.

The ruin is circular as stated, and was undoubtedly built as a fort to hold the spring. It is literally a walled village. It also holds our interest from the fact that below it on the rock face of the mesa front above the spring are two circular drawings about a foot each in diameter, probably representing the sun and moon. Below the moon (smaller) drawing there is a crude, almost effaced drawing of a mountain sheep, and below the other drawing there is a crude drawing of a human being. Below these are names of civilized men, as follows:

PETE
R PAINE
P H GAN
TROOP H
102466
J OBERMAN

Near this there are said to be Spanish inscriptions of the Seventeenth Century, but because of lack of time, the writer did not see them.

No. 213. About two miles east of Pete Springs there is a conspicuous stone mound topping a ridge just a little to the northwest of the road. The mound is 8 feet high by 22 paces in length and is surrounded by an immense number of potsherds, especially on the east, the dump-heap, graveyard side. It was evidently occupied for a long period, judged by its abundant potsherds.

Tanner Springs Ruins. About thirty miles southeast of Kintiel is a series of springs known as Tanner Springs, the water of which is now impounded and used for watering the sheep herds of the region. The springs are large and the quantity of water that emerges through them is very considerable, enough to irrigate a large area of land if properly distributed. Adjacent to these springs to the south and east are vast flats which were undoubtedly used for farming by the ancients. The region about the springs, especially to the west and northwest, a rising bench area, is a sand dune swept region, a giant dune now advancing on the springs from that section.

The ancient inhabitants built their villages on this northwest ridge overlooking the springs and the flats adjacent, and for a distance of more than a mile up and down this ridge and on a ridge farther to the west, across a little canyada, village debris jots above the shifting sand now and then in the shape of house walls, ancient altars, sherds, grinding slabs, pestles, and mortars. In the present

state of the ruins it is, however, impossible to estimate their size and extent, or the approximate number of people that lived in this village when it dominated this region.

ARCHAEOLOGY OF THE CORNFIELDS-HOPI BUTTES FIELD ARIZONA, 1926 REPORT

The writer's archaeological investigations of 1925 were a continuation of the work in the Cornfields-Hopi Buttes Field, the ruins examined being as follows:

No. Z-172 (171 1-2). This is a small ruin on a ridge one-half mile east of No. 171 (of my previous reports). No more than twenty people ever lived in it.

Nos. Z-173 to Z-180. These ruins might be termed the Greasewood ruins, as they top a series of sand ridges in the middle-flats east of Pueblo Colorado Wash, about halfway between Sunrise Springs and the old Murphey store at Greasewood. They also used the same lands and the same water supply as the people of villages 204-206 on the opposite side of the wash, as will be described later, the same as the Navajos use today.

No. Z-173. This ruin covers a north-and-south running sand ridge, on all slopes, south of the road south of Pueblo Colorado Wash, about eight miles south of Sunrise Springs. The village was built of flag-tuff, along the top of the ridge, in a north-south line, extending in segments a distance of about 105 yards, but time has completely leveled the buildings. The debris now extends down the slope of the ridge 125 feet to the west and down the east slope 140 feet. The pottery shows the village to have been occupied from in the slab-house stage about through the black-and-white pottery stage. The village was large and was occupied a long time.

No. Z-174. This village is on a sand dune north of the same road (old Cornfields-Murphy-Holbrook road), about six miles south of ruin No. Z-173. The ruin which is completely laid flat was built in a north-and-south direction, with extent of probably 50 feet. It was not large, though the pottery is now scattered about it far and wide. There are also rock piles about the site that probably represent ancient graves, though no bones were found beneath them. The pottery showed itself to extend in time into the three-colored-ware stage. Even yellow pieces, painted in black and smeared over with white, showed now and then over the sand blown surface about the site. Probably 100 people occupied this village.

No. Z-175. This ruin is on a sand ridge one-eighth mile northwest of Z-173, and is of similar construction and state of "decay" as that ruin. It is 100 yards long and probably twenty paces in width, but is now completely leveled. It was built of white, thin-bedded tuff.

Its pottery shows that it was inhabited in the slab-house stage through the black-on-white pottery stage into the two-color (red) pottery stage, though the red-colored sherds are scanty. It was a very large village with a very large refuse heap which is now almost leveled. Much pottery, often of very large pieces, is scattered over the site.

No. Z-176. This is a ruin on a hill across a sag, one-eighth of a mile about due east of No. Z-175. The village was about twenty paces in length, but is now leveled. A circular building of large size, some distance east of the main building, has been dug into, a human femur having been dug up and thrown upon the excavated dirt. There is but little of a refuse pile now showing. The pottery is scanty and all of the slab-house type.

No. Z-177. This is a completely leveled village, neither village mound nor refuse pile showing. The pottery, which is of the slab-house type, is scattered over a large area of probably 100 yards circumference.

No. Z-178. This is a ruin on a knoll about one-sixteenth mile northwest of No. Z-177. The village mound, which is now leveled, shows that the village, which was only about thirty feet in length, was built of white, thin-bedded tuff. The refuse heap is small. The site is strewn with considerable pottery, which includes three-color-painted ware, including a buff-painted piece, painted over with black and daubed over with white-smeared designs.

No. Z-179. This ruin is on a little ridge that projects northwest ward from the ridge on which No. Z-178 is located. But few sherds now cover the site and these are near the slab-house stage of pottery. The village which was small, is now leveled.

No. Z-180. This ruin is on a sand ridge just across a hollow 400 yards northeast of Nos. Z-178 and Z-179. It is similar in construction to Nos. Z-173 and Z-175, of about the same age, and in about the same state of preservation. It is a little smaller than either of these two ruins.

No. Z-181. This is the ruin of a wide-walled, village section, built north and west and having a large plaza depression southeast of it, with four detached stone mounds southeast of it in a sort of strung-out, southeast-northwest line. The ruin tops a ridge one-half mile northeast of the ruin of Kinlechee, its plaza facing the same farming lands as the plaza of that village. A rather large village was here. Though now leveled, it is represented by a large, conspicuous mound. The pottery fragments are scanty, and the refuse heap and dump pile is very small, showing that the village was not long inhabited.

No. Z-182. This represents a series of cave ruins along Pueblo Colorado Wash, about six miles northwest of the pueblo ruin of Kinlechee, in the vicinity of the crossing of the Sawmill-Ganado road. The stream here has cut down deeply into the DeChelly sandstone, a total of 200 feet in some places, and has shelved and gouged itself into the cliff here and there as it lowered its channel. It is in these gouged-out, shelf-places that are the caves used by the ancients.

All the caves and cliff-shelters examined, covering a distance of about a mile and a half along the stream, were on the south side of it as the stream runs in this section; no place having been used by the ancients on the opposite bank in this area. The caves and cliff-shelters are all small, probably averaging a sixteen-foot front, a height of six feet, and a distance back from the entrance of probably seven feet. All at one time had front walls, but now only two show such walls.

Just at the crossing, a small cliff house, high up along the wall, has its front wall and some of its side walls still intact; another, one-half mile up the wash has a two-foot wall showing in place about its front. All show smoked walls and all have potsherds scattered on the slope below them, sherds of the carrying, storage pottery type, only. A sloping area under the rock-front, at about the level of a recent flood plain of the creek, shows evidence of occupation, for a distance of 100 feet. If any walls were ever there they are now wholly gone.

Note: On the trip on which ruins Nos. Z-181 and Z-182 were found, we went diagonally across the country northeastward over the Defiance Plateau, through Buell Park to Chee Dodge's ranch near Sonsela Butte, returning via the present government sawmill at the head of the Chinle over-mountain road. In the Buell-park region we saw a beautiful open country with many nice farms, and houses, which for Navajos, were very fine. But we were much disappointed; for, after crossing Pueblo Colorado Wash four miles northeast of the pueblo ruin of Kinlechee, we saw not a single ruin nor any indications of ancient habitation, though crops are now raised by dry farming, and there are springs in the region. Moreover, not five miles below the government sawmill in Canyon de Chelly there are the world-renowned cliff ruins by the dozens, scores, and hundreds. The only satisfactory explanation as to why the region was not inhabited in ancient times is, that it was too cold for permanent habitation, being 7,500 feet above sea level; the Navajos even today move to lower levels in winter.

Nos. Z-183 to Z-188. These ruins are all west of Pueblo Colorado Wash six to ten miles below Sunrise Springs and all but No. Z-183 are west of the present Cornfields-Holbrook auto road, Z-183 being below (south of) where that road leaves the valley through a natural pass about seven miles southwest of Sunrise Springs.

No. Z-183. This ruin tops the center of the front (east side) of a 300 foot high mesa that faces Pueblo Colorado Wash from the west side of its valley below the gap where the road leaves the valley. It undoubtedly was put there for defense and as an observation station, for from it the whole valley and its then fields could be viewed for miles. The ruin which is in three segments is 60 paces in length in a north-and-south line, the trend of the mesa-face. It was built of friable white tuff which, though crumbled with age, now makes a conspicuous set of village mounds. Some rooms show in the heaps. The pottery is not abundant and is of the slab-house type. One whole

jar was obtained. It is now in the possession of Mr. Paul E. Gradall of the farmers station here who plans to place it in the University Museum at Tucson. The jar is characterized by having the double scroll pattern dominant in the decoiation. This village is of interest; for, though of the club-house type in pottery-make, its segments are large mounds and rooms show in the mounds, without any so-called slab structure showing in the make-up of the walls.

No. Z-184. This is a "flattened" ruin on a knoll west of the road, about two miles north of where the road passes out of the valley through the above-mentioned gap. Much pottery of the black-on-white type covers the site. The size of the village cannot be conjectured now.

No. Z-185. This is a very small village ruin on a knoll about 300 yards west of No. Z-184. Some scanty sherds of black-on-white pottery mark the site.

No. Z-186. This is the "flattened" remains of quite a village, topping a knoll, about one mile north of No. Z-184. A considerable number of sherds mark the site.

No. Z-187. This is a ruin along a long ridge, about one-half mile north of No. Z-186. It is completely flattened, though foundations of several rooms show. There is evidence that it was large, but its exact size cannot now be be conjectured from its present state. Its sherds, which are not numerous and are scattered over a wide region, are of the slab-house type.

No. Z-188. This ruin is on the down slope side east of a hog-back running north and south, just west of the road, one-fourth of a mile north of No. Z-187. Many pottery fragments of the black-on-white type mark the site, as does considerable scattered building material.

No. Z-189. This ruin is on the east side, at the edge of a flat-topped mesa, about one and a half miles north of ruin No. 143. It was not a large village. It is now a conspicuous mound and has an abundance of potsherds scattered about it.

No. Z-190. This comprises a large ruin or set of ruins, topping and flanking a long ridge-knoll, about one mile north of ruin No. Z-189. The debris covers one-eighth of a mile in length and 400 yards in width. The debris divides itself into the following segments; a southwest (190 SW) set of mounds, three in number, situated on a lower bench of the ridge, with scattered sherds all about them; a south set of mounds (190 S), two in number, at the south end of the main knoll and much scattered pottery about them; a large area on the east flank of the knoll (190M) in its lower reaches, over which there is much scattered pottery, but no mound is visible; and a north segment (190N), with several mounds topping the north end of the knoll and many pottery fragments flanking the northeast slopes of the ridge. The pottery of 190 M is mixed slab-house type and black-on-white; the pottery of the other segments is black-on-white, in type. Probably 500 people lived on this ridge.

No. Z-191. This ruin is one and one-half miles northeast of ruin No. 10, and is of a similar size and of about the same age as that

ruin. It makes a conspicuous mound. It is of the black-on-white pottery series, in age.

No. Z-192. This ruin is on the west side of a side arroyo, about a mile northwest of No. Z-191, about a mile northeast of ruin No. 10. It is a conspicuous mound, showing two north-and-south tiers of room heaps, the east tier now being the larger mound. The pottery shows this village to have flourished in the black-on-white pottery stage of ancient culture.

No. 214. This ruin is on a little knoll in the flat one-fourth mile nearly south of No. 76. It was 300 yards in length in an east-and-west direction, being now wholly leveled. Many sherds, all of the slab-house type, mark the site, placing the village in the slab-house division. Probably 100 people lived in this village for a long period of time.

No. 214 A (formerly No. 215). This is a small house ruin, one-eighth mile south of No. 214. A part of it was built of Chinle limestone, which had been carried half a mile. A fragmentary basaltic metate, which had been obtained about twenty-five miles distant, was found on the site. Some twenty-five people lived in this ruin.

Nos. 215-216. These ruins are west of a shallow basin that contains water a part of the year, a mile over the gap through which the Cornfields wagon-auto road passes out of Pueblo Colorado wash valley, eight miles a little west of south of Sunrise Springs. No. 215 is the north ruin of the two, topping a little mound-top of a ridge. No. 216 is about a mile south of 215, topping the south end of the same ridge. Both villages are completely leveled, their sites being strewn with a few rock, and occasional house mound, and some scanty pottery, all of the slab-house type.

Nos. 217-222. These ruins are all in the valley of Hogay (Steamboat) Wash, from one to three miles below (southwest of) Bear Springs (ruin No. 121). They are also all in the "foothills" of the valley, between the wash and the mesa-juting points, promontories and ridges to the eastward. All are "leveled" ruins, some of which show only pottery fragments to mark the site. Nos. 217, 219 and 221 carry slab-house type of pottery, and Nos. 220 and 222 carry black-on-white painted pottery. The pottery of the other ruins was not determined.

No. 217. This ruin is the south ruin of the group, topping a little ridge east of the wash, about three miles below (southeast of) Bear Springs (ruin No. 121). Two mound-sections show, with a considerable quantity of potsherds scattered here and there about them.

No. 218. This ruin is one-half mile northeast of No. 217. Nothing but potsherds and a few cobbles now mark the site.

No. 219. This is the north ruin of the group. It tops a foot-hill-ridge northwest of the first high promontory that projects into the creek valley from the mesa eastward, about one mile southwest of Bear Springs (ruin No. 121) and two miles northeast of No. 217. It had been quite large. Some of the mound of the village still shows and many potsherds mark the site.

No. 220. This ruin is one mile southwest of No. 219 and one mile northeast of No. 217. Only potsherds mark the site.

No. 221. This ruin is at the southwest point of the promontory, opposite (southeast of) N. 219.

No. 222. This ruin is just east of the middle-west-front of the second promontory below No. 219. Only scattered potsherds and a low mound now mark the site.

No. 223. This ruin (or set of ruins) tops the promontory opposite (southeast of) ruin No. 219. No village site can now be determined from mounds, but potsherds are scattered here and there over a large area, extending the whole length of the ridge-promontory, a distance of one-fourth mile, the most pottery being exposed along with much rock at the northwest terminus of the promontory. The village or villages are very ancient and have been completely leveled, leaving the sherds and a few cobbles to mark the sites. The pottery is all of the slab-house type.

Nos. 224-226. These ruins are all on the second bluff, about four miles about straight south of the Cornfields Day School, a little east of ruin No. 136. No. 224 is now quite a mound of rock, east of which there is much scattered pottery. No. 225 is a series of ruins or segments of a single ruin, extending along the west face of the mesa for a distance of an eighth of a mile. Four major segments (stone heaps show and several smaller ones. The pottery about this site was scanty.

No. 226. This ruin is about one-eigth of a mile east of No. 225 and about the same distance from 224. It shows a conspicuous stone mound, with a rather deep plaza-depression, east of which the earth-mound is large.

ARCHAEOLOGY OF THE CORNFIELDS REGION, ARIZONA. 1927 REPORT

The work of this year was a continuation of the previous work as follows:

Additional Ruins found (numbering them from the last number in my 1926 report.)

No. 227. On a south projecting point of the mesa, north of an east-and-west running dry arroyo, one-fourth mile east of ruin No. 45, about three-fourth mile east of Sunrise Springs, there is a ruin now represented only by scattered cobbles of which the buildings were made, accompanied by scattering of apparently the middle Pueblo series of the region. The village was rather large but has been mostly removed by erosion. The southeast wagon road from Sunrise Trading Store climbs up the mesa across this ruin.

No. 228. This ruin is on a hill inland, about a mile southeast of No. 227. It is so badly worn down that its size could not be estimated.

No. 229. This is a completely flattened ruin, about a mile southeast of ruin No. 228. Its debris consists of cobble stones, building wall debris, accompanied by scattered pottery and grinding slabs.

No. 230. This is a pit-house ruin on a knoll three miles southeast

of the Cornfields Day School, near Smiler's (Hosteen Shemar's) hogan. It consists of a depression some 16 feet in diameter, with a slightly raised border. A few scattered sherds of the period just after the slab-house stage of culture of the Pueblo era are scattered about the site.

No. 231. This ruin is on a ridge running northward from the big bend in Sabito Wash, eight miles east of Cornfields Day School, across the creek from "the wells" on the road from Ganado to Sanders on the railway, via Klegotoh. No ruin now shows, neither do any depressions for pit houses, but all along the south slope of the ridge broken pottery is exposed in ravines for about a quarter of a mile. The pottery seems to belong to the beginning stage of Pueblo culture in the region. Such time has elapsed and the wear of the country has been so great that all signs of the places of habitation, whether of single house, pueblo, or pit-house type, have been obliterated. It is the writer's opinion that only hunting lodges and lookouts ever occupied the site.

No. 232. This ruin is similar to the last. It is situated on the Cross-Canyon road three miles northeast of ruin No. 231. It also seemed to be of about the same age.

Nos. 233 to 236. These ruins are across the wash, a little east of north of the Cornfields Day School. They are near, or a little to the east of the old Ganado-Cornfields road on that (west) side of the creek, from two to five miles from the school. They are not far from ruins 13 and 14 of my previous reports. They, too, possess slab-house pottery like those two ruins or just the beginning of the black-on-white pottery series that follows the slab-house age.

No. 233. This number represents the scattered remains of a ruin that is all but obliterated. The pottery is scattered over a large area. The size of the village cannot now be conjectured. It is situated about a quarter of a mile northeast of ruin No. 13. Its pottery is of the slab house type.

No. 234. This ruin tops the east edge of the bench, a little less than half a mile northeast of ruin No. 13. Much village debris marks the site, but no walls are in place. The village seems to have been in an east-and-west line. Its pottery, too, is of the slab-house type.

No. 235 This ruin is on the same mesa-ridge, about a quarter of a mile north of No. 234. Much debris and much pottery of the beginning black-on-white type mark the site. It had been a large village.

No. 236. This is a ruin topping a point about a quarter of a mile northeast of ruin No. 235, and abut a mile southeast of No. 14. It had been a small village, probably having been a lookout. No walls can now be seen. The pottery was of the beginning of the black-on-white type.

No. 237. This ruin is on the west slope, about a mile east of the old Cornfields-Ganado road, west of the main wash, 2 miles about due north of ruin No. 236. It is the ruin of a small village and is

now represented by a pile of cobbles, a small depression, and some pottery fragments, which are of the slab-house stage.

No. 238. This ruin is just east of the old Cornfields-Ganado road, just before the road reaches the limestone cliff-ridge of Chinle rock, at the top of the anticline, 4 miles north of ruin No. 237. It was a very small village, now wholly flattened with age. The scattering pottery is of the slab-house type.

A Skeleton with Unflattened Skull.

A skeleton, skull undeformed by a cradle board, showing that it possibly antedates the Pueblo period in age, was found exposed under the refuse heap of ruin No. 40, two miles east of north of Cornfields. Ruin 40, as per my previous reports, overlies an older pueblo, numbered 39 on my list and previous reports. Whether the skeleton belongs to the early stages of ruin No. 39 or to the period just before the beginning of the Pueblo stage cannot be definitely stated with the data at hand, but in appearance it belongs to the latter period. No pottery was found with the skeleton, which also seems to verify this conclusion. Two human skeletons had occupied the site, together with the skeleton of what in the field, the writer takes to be a skeleton of a dog, the third instance of his finding dogs in graves in this section. Similar burials have been reported by others, especially by Fewkes, and by Kidder and Guernsey. The dog skeleton and that of the other human being were also exposed and are only fragmentary, though the skeleton of the dog was interred under the two human skeletons. The burial indicated that probably these people and the dog were killed in battle, as the position of the one human body intact indicated that this body had been hurled roughly and in twisted form into some pit and left there. It was all doubled up, with one hand thrown out and the legs twisted up over and "slanchways", crosswise the body. The bodies were reinterred on the site.

Places That Should Be Made National Monuments by the Government.

The famed Inscription Rock is in New Mexico, but Arizona has chiseled records, as well.

The old route from Zuni and the East lay through Ganado, Steamboat and Keams Canyon, Arizona, to the Hopi country. Over this route the Spaniards (and Mexicans) traveled back and forth from the days of Coronado till the time when the United States took possession. Then our government's soldiery and exploring-surveying outfits traveled it. Moreover, at three or more places along this route between Ganado and the Hopi villages records were left since we occupied the country, and at one place during Spanish times.

Seventy-two miles west of Gallup New Mexico, and 18 miles west of Ganado, Arizona, as one journeys westward toward the land of the Hopi Indians, he enters what is known as Steamboat Canyon, near Steamboat, Arizona, so named because an isolated rock within it resembles an old side-wheeler. Proceeding on westward, he rounds the point of the mesa to the north of the canyon and there in a side canyon is a spring, locally known as Sheep Springs. And should neces-

sity cause him to go there for water he would be at once interested, for the names of many army men are chiseled on the perpendicular rock-walls of the inclosing mesa.

Directly above the springs the chiseled hand of an Indian is clasping the hand of a white man in friendly grip. Near this there is chiseled a flag containing twenty-six stars, all the stars the space would hold, and below this and the hand-clasping scene, is the inscription, "Colyer, 1869", probably the name of the man who made the drawing and the date he made it. Near this on the rock walls and on the sides of fallen boulders are many other inscriptions, some of which are: "Vet WN (probably Wm.) H. H. Terry, Nov. 1870; H. Wil—Nov., 15, 1866, Company—Troop H. 5. Syracuse, New York; J. T. Duffy, 1853" (at another place nearby this man's name is again incised "J. T. Duffy, C. K. B. W. F."); "George L. Filbin, Kewosha (or Kenosha), Wisc., Nov. 16, 1866, Troop H "5" U. S.; R. Payne, Dayton, O., 1866."

There are many more names on the rocks and mesa face thereabouts, but a furious cloudburst drove myself and my Navajo guide, John Curley, from the canyada and I never had a chance to return to it again.

Nine miles west of Steamboat, in a little side canyon to the north of the Ganado-Keams Canyon auto road, there is a spring which is called "Pete Spring", in English, because a man by the name of "Pete" chiseled his name in bold letters on the canyon-wall face directly above it. It is also called "Pashbitoh" (Pipe Spring) by the Navajos because the water is piped from it in an iron pipe.

In the long ago this spring furnished water for ancient peoples who farmed the flat lands adjacent. Here on the very edge of the mesa which is thirty feet in perpendicular height above the water of the spring, they, too, erected a circular fort-village, 106 paces in circumference and 33 paces in diameter, whose walls still stand 7 to 10 feet in height, so that the spring was commanded by arrow shots from its walls. This ruin is called Eighteen Mile Ruin.

This village and spring hold interest because Spanish inscriptions of the seventeenth century are said to be near them, and that besides the Indian inscriptions of the sun and the moon, a drawing of a mountain sheep, and that of a human being on the mesa face directly above the out-bubbling water, there are names and a date that remind us of our troubled times in this region, as follows: "Pete, R. Paine, P. H. Gan, J. Oberman, Troop H, 10-24.66."

In Keams Canyon, close to the government post of Keams Canyon there is an inscription made in 1863 by one of General Kit Carson's soldiers at the time he and his men were camped on the old Keams Canyon village site. It reads: "Ist Reg't New Mexico Vol. Aug. 13, 1863, General Kit Carson, Commander." It is carved on the face of a smooth cliff of gray sandstone by a steady accurate hand, long since laid to rest, no doubt. Close by is a lonely, sunken grave, unmarked and only sponsored for by old Ukuema, chief of the Hopis at Hotavilla, who remembers when Carson came to protect the Hopis

from the raiding bands of the Navajos and to settle the trouble between the two tribes.

Just before entering Marsh Pass from the southwest, on the Tuba-Kayenta road, the ruin of a considerable ancient building stands on an elevation, about a mile northwest of the road. Its two long, parallel walls rise in places to a height of ten feet, showing indications of two stories, some of the rafters in places still projecting beyond the face of the walls.

The walls are composed of roughly laid masonry, bearing evidence on the inside of having been plastered. On the outside, many of the rocks are polished and are decorated with deeply incised geometric figures, apparently traced with some pointed instrument.

This ruin is known by the name "Ruin A", or "Tecolote" (the Mexican-Spanish for ground-owl, from Nahuatl tecolotl). It was known to white men many years ago and visited by prospectors, relic hunters and soldiers. Here Lieutenant Bell, 3rd Infantry, U. S. A. (probably William Hemphill Bell) carved his name, with the date, 1859.

Some twenty miles to the west of Ruin A and Marsh Pass is a group of cliff ruins, with walls still standing, and called "Inscription House." It, too, is of special interest; for a Spanish soldier, Ghos by name, visited it and left his inscription thus: "Ghos, 1661, Ano."

These places with the inscriptions from those by-gone days, should stand in remembrance of a work well done by those soldiers and their equally brave comrades, and the government should take steps to preserve them.

ARCHAEOLOGY OF THE CORNFIELDS REGION, ARIZONA, 1928 REPORT

The work this year was a continuation of last year's work, as follows (the ruin numbers beginning where that report left off).

No. 239. This ruin is on a knoll, one-half mile southeast of the wells, seven and one-half miles southeast of Cornfields. It was a small village, now completely flattened.

Nos. 240-248. These ruins are on a ridge west of the headwaters of Wide Ruin creek and adjacent to same, running somewhat in a north-and-south line, the direction of the ridge. The distance between No. 240 and No. 248 is probably a mile, and the southeast end of the ridge is about five miles north of Klegith Trading Store. The people of the villages farmed the same land along Wide Ruin Wash that the Navajos do now.

No. 240. This ruin is of a village that was about 100 feet long in a north-south direction, the direction of the ridge. It is now completely reduced, due to the wearing back of the ridge-front on which it was situated. Much broken pottery and rock of the fallen walls now mark the site.

No. 241. This ruin is down near the creek bottom. It there tops a little ridge, rocky projection, one-half mile south of Ruin No. 240.

It was evidently a watch tower and was very small, probably 16 by 12 feet in dimensions. Scanty pottery fragments mark the site.

No. 242. This is a massive ruin in D-shape, topping a ridge, 400 yards due south of ruin No. 241. The heap of its crumbled walls, the straight line of the D, is now 7 feet high. Probably 100 people lived in this village. Many pottery fragments cover the whole-ridge slope southeast of the ruin, which seems to indicate that the village was long inhabited.

No. 243. This ruin is in the timber, about 300 yards approximately south of Ruin No. 242. It is now completely reduced to the level. Rocks from the walls and a considerable number of potsherds mark the site. Some fifty people occupied this village.

No. 244. This is a completely reduced ruin, in the woods, about 400 yeards east of Ruin No. 243. The village was small. Some potsherds and building rock are now scattered about the site.

No. 245. This is a small ruin in the woods, about 200 yards east of Ruin No. 244. The potsherds here are scanty.

No. 246. This ruin tops the southeast point of the main ridge, one-eighth mile south of Ruin No. 245. It is the ruin of a large village, whose walls are now in heaps. About one hundred people lived here at one time. Many pottery fragments are now scattered over the site and about the refuse heap.

No. 247. This ruin lies on the first bench, about 600 feet east of Ruin No. 246. It was a fairly large village, in about the same state of preservation as No. 246 and probably originally of about the same size.

No. 248. This is a series of rock mounds, on a still lower bench, about southeast of Ruin No. 247. It is scattered over a large area. Probably 200 people lived in it at one time. The scanty potsherds would seem to indicate, however, that it was not inhabited long.

No. 249. This ruin is in the timber, eastward across the wash from the last mentioned ruins. It was not examined on account of lack of time.

No. 250. Across Pueblo Colorado Wash, north of Ganado Mission near Ganado, the point of the mesa comes nearly down to the wash. Between it and the wash there is a small "foothill" ridge, from which the fluvial bench, here only 50 feet wide, extends to the creek canyon. On the "foothill" ridge there is a stone mound of a "small house" village, running in a southwest-west-north-northeast direction, the trend of the ridge. The mound is 17 paces long and only 4 paces wide. On the lower level there is also village debris where a part of a room shows. This village site seems to have been inhabited at two different times; or, if continuously, it was occupied in the slabhouse stage of culture up into the beginning of the red and yellow pottery stage which seems improbable, as the intermediate, the black-on-white stage, is not represented. However, the lower part of the main village, the village on the lower level, may have been washed away by the creek. The slabhouse pottery is scanty, as in the more advanced type.

No. 251. This is a ruin in the flats east of Pueblo Colorado Wash, about one-eighth mile northeast of Ganado Mission. The mound is now 3 or 4 feet high and is somewhat circular in form, with the two exits of the village still shown by depressions in the mound. The mound is 17 paces across in a northwest-southeast direction and 12 paces along the opposite diameter. Very little rock was used in the construction of this village. The pottery is scanty and all of it is of the slabhouse type.

No. 252. In the flats between the mesa mentioned in No. 250 and the irrigating ditch, about a mile north of Ruin No. 251, northwest of Pueblo Colorado Wash, there is a ruin of a much scattered village, the two main segments being nearly north-northwest and south-southeast of each other. The south segment shows the stone pile of the village walls of a "small house" of fairly good size; and the north mound, which is a flattened refuse heap, shows some signs of having had buildings on it, also. A skeleton and some whole pottery are said to have been found here. It would seem, from appearance, that this village was inhabited a long time and has since suffered much from the ravages of time. The pottery is of the slabhouse type.

No. 253. In examining the ruins above (Nos. 250-252) the writer was aided by the Mission employees, Messrs. Benets and Haldeman, and an Indian boy who located the ruins for him. After completing the examination of Ruin No. 252, the Indian boy directed us to another ruin on the top of a sort-of-twin buttes, up the same side wash that Ruin No. 252 is in, about a mile approximately north of that ruin. No village now shows, but scattered debris, cobbles, rocks of which the walls were made, and many potsherds flank the buttes on all sides, extending out onto the adjacent flats in some places. The position of the buttes would seem to indicate that the village (or villages) were outposts used to guard the valley farms. The pottery obtained seems to be that of the closing epoch of the slabhouse stage.

Ruins Nos. 254-257. These are ruins of the small-house village type, on the edge of the high mesa, east of Pueblo Colorado wash, south of the "third road" that climbs the mesa east of that wash, four miles below (southeast of) Sunrise Springs, the mesa there being close to 250 feet in elevation above the wash. Each village has been built of Tertiary sandstone-tuff and its site is now marked by a crumbling mound. A few pieces of red pottery, red on each face but otherwise undecorated, were found in each ruin. On the whole, however the pottery of each ruin is of the reminiscent slabhouse type to the beginning of the black-on-white ware series.

No. 254. This is a considerable ruin, oriented in a north-south line, just at the top of the mesa where the "third road" below Sunrise Springs climbs the mesa. It is just south of the road and is about 25 feet long and about 14 feet wide. East of this there is a considerable area covered with the refuse mound over which much pottery is scattered. From indications, about twenty-five people lived in the village and lived there a long time.

No. 255. This is a ruin about half a mile south of No. 254. It is

very similar to the latter but smaller. The potsherds about it are scanty and are scattered over a large area. Probably fifteen people once lived in the village represented by the stone heap here.

No. 256. This ruin is 200 yards south of Ruin No. 255. It now shows very slight remains of a village in the form of a low mound around which some potsherds are sparingly scattered.

No. 257. This ruin is one-half mile south of Ruin No. 256. It now shows a small stone mound, almost submerged in sand, around which there are scanty potsherds.

No. 258. This ruin is at the north foot of Neubert's Organ, three miles northwest of the Cornfields Day School. Most of the village had been removed by erosion. A few scattered rocks and scanty pottery of the black-on-white type now mark the site.

Ruins 259-260. The promontory-mesa east of Pueblo Colorado Wash, east of Sunrise Springs, is divided into sections by cross washes of various lengths leading down from the mesa to the main wash. As has been noted previously, the mesa top adjacent to the wash is dotted with ruins. The ruins on the sections just east of Sunrise Springs were examined several years ago and given the numbers 145-155. Recently the third section below Sunrise Springs was visited, the ruins then found being numbered 254-257. Just recently (August 20, 1927, to be exact) I visited the middle section and found two ruins there before darkness drove me from the mesa. These ruins are in a section between ruins Nos. 155 and 254, previously described, the section being about a mile and a half in length, extending in a north-south direction.

No. 259. This ruin is nearly a mile south of Ruin No. 155. It is the ruin of a rather large small-house village which was made of volcanic tuff, now forming a conspicuous pile east of which many potsherds are scattered down the sloping ridge on which the village is situated. Probably thirty people lived in this village.

No. 260. This ruin is half a mile south of Ruin No. 259. It is now a conspicuous mound of shaley tuff-rock, east of which there is a large depression. East of this depression are the remains of the refuse heap where much broken pottery shows. It is a small-house village in which probably forty people lived. Darkness coming on prevented me from getting much of a pottery collection from this village site.

No. 261. This ruin is on the mesa bench, 400 yards east of where the Ganado Monoclinal ridge meets the mesa bench east of Pueblo Colorado Wash, about halfway between Cornfields and Ganado. It is a small-house village ruin of the beginning black-on-white series pottery-type. It was built of Tertiary rock and Chinle limestone and still makes quite a pile. The pottery is scanty about the site. Probably 25 people lived in this village and farmed in the flats along the adjacent wash to the northward.

Ruins 262-263. These ruins are on the mesa west of the Pueblo Colorado Wash, south of Sunrise Springs, about opposite ruins Nos.

259 and 260. They are very similar to the latter and show about the same stage of culture.

No. 262. This is a ruin of a fairly large small-house village at the top of the mesa, west of Pueblo Colorado Wash, about two miles south (down the valley) from Sunrise Springs. It now makes a conspicuous mound of crumbled walls, which are composed of Tertiary volcanics. The pottery about the site is scanty. Possibly 50 people lived in this village.

No. 263. This ruin is near the east edge of the promontory-mesa, about a mile south of ruin No. 262. It is of about the same size as that ruin and its pottery fragments show it to be of somewhat the same age. About it are many scattered pottery fragments.

No. 264. This ruin was probably a watch tower or lodge on a hill adjacent to their fields, now farmed by Navajos, northwest of the Ganado-Steamboat auto road, about five miles east of Steamboat store. About the site are some scattered cobbles and some scanty potsherds. Its size cannot now be determined.

Ruins Nos. 265-273 close to Fifteen Mile Ruin, in the vicinity of Peshbitoh (Pete) spring, near the Keams Canyon-Steamboat road, 15 miles east of Keams Canyon and nine miles west of Steamboat. The Fifteen Mile (Pete or Peshbitoh Spring) Ruin, from which pottery was collected in 1923, is a circular fort affair on a promontory overlooking Peshbitoh (Pete) Spring, which it was no doubt built to defend. The potsherds of the ruins in the vicinity here visited, show pottery resembling both Zuni and Hopi types, apparently all of the Middle Pueblo stage, all much older than the pottery found at the circular (Fifteen Mile) village.

No. 265. This ruin is on the second ridge, on top of the bench on which Fifteen Mile Ruin is situated. It is a small-sized pueblo, whose pottery shows an admixture of Hopi and Zuni ware.

No. 266. This ruin is in a narrow canyon, just across the wash, about a hundred yards west of the spring. It was a small village which was apparently hurriedly abandoned when a thousand ton boulder rolled on it from the cliff. Near this ruin is the remains of a circular kiva which was built, in part, against the east face of the west inclosing mesa; and near it, on the adjacent mesa cliff, a smooth rock face, 10 feet by 15 feet in area, is covered with ancient pictographs. At the south point of the mesa, on the same side of the wash as the springs, there are also many more pictographs.

No. 267. This is a ruin of a fairly large village whose walls, with the burial-dump-camp site, form a circular area 40 feet in diameter. Its debris is very shallow, showing only very frail potsherds of the Hopi type of pottery. About 100 people lived in this village.

No. 268. This village ruin is on a ridge down the old Keams Canyon road, two miles below Paul Williams' old store building, five miles below (east of) Fifteen Mile Ruin and four miles west of Steamboat. It is the ruin of a small village in which probably 30 people lived. It shows evidence of having been built of adobe only.

The refuse-debris here is three feet thick, while the potsherds were only scattering.

No. 269. This is a ruin on th next ridge east of Ruin No. 268, some 300 yards distant from that ruin. It is the ruin of a small village of the small-house type, about which only a few sherds are scattered on the sloping hillside. About 25 people lived in it.

No. 270. This is a small ruin, a little to the southwest of the last village. A small rock-mound marks the site, about which the potsherds are scanty.

No. 271. This ruin in on the toe of the ridge on which Ruin No. 269 is situated, some 300 yards southeast of that village. It was a very small village, about whose site only scattered potsherds are now scattered.

No. 272. This ruin is on a low, flat-topped area in the flats, about half a mile northeast of Ruin No. 268. It is the remains of a medium sized one-tier pueblo which was occupied for a long period of time, as its potsherds are numerous and the depth of the refuse heap, which is very large, exceeds three feet. The village, with the refuse heap-burial ground, forms a circular area 80 paces across. Possibly 150 people lived in this village and lived there a very long time.

No. 273. This ruin is on an isolated mound, about one-eigthth mile northeast of Ruin No. 272. It is the remains of a rather large village, below which potsherds are scattered down the slope for a long distance. A peculiar thing discovered here was a human skull placed on an altar, something the writer has never seen before.

No. 274. The Steamboat road crosses this ruin about a mile northeast of Steamboat Rock. The village mound is practically obliterated, but the refuse heap-burial site shows a depth of debris of approximately three feet. The village was apparently small, but was inhabited for a long period of time.

No. 275. This is a small ruin over in among the trees about a mile nearly northwest of Ganado Mission. It is in the foothills east of Ganado mesa. The pottery is scanty, of the black-on-white type.

No. 276. This ruin is among the pinyons in the foothills, near the northeast point of Ganado Mesa, about a mile and a half nearly north of Ganado Mission. It was a small-house village, about whose site considerable black-on-white pottery of the early black-on-white stage is scattered.

No. 277. This is a very large village, topping a knoll in the "foothills", about east of the north point of Ganado Mesa, approximately two miles about north of Ganado Mission. The village shows innumerable rooms of the slabhouse type, with the slab-rock still standing on edge. Three plaza-depressions show, as do those of several kivas. Some one has done considerable excavation work about the graveyard site, but apparently did not obtain much. The pottery is mostly of the slabhouse, reminiscent black-on-white type and in sherds it is profusely scattered about the site and all about the slopes of the hill on which the village was situated. The writer judges that 500 people lived in this village when it was at the zenith of its power.

No. 278. This is a small slab-house ruin in the flat, about three-fourth of a mile northeast of Ruin No. 277. Its pottery is scanty, but apparently of the early black-on-white type. Two empty cists were noticed at this site.

No. 279. This ruin is situated on a ridge-hill at the head of the Chinle flats, east of the Cornfields-Steamboat road, about eight miles a little east of north of the Cornfields Day School. It is the remains of a fairly large village, about which much potsherds are scattered. It seems to have been an outpost village.

No. 280. This ruin is being exposed by a new-cut arroyo that the road crosses west of Pueblo Colorado Wash, about half way between Cornfields and Sunrise Springs. The village, which was of the small-house type, had been completely covered but the recent canyon cutting has exposed it again. The pottery is of the beginning black-on-white stage.

POTTERY TYPES IN THE CORNFIELDS-HOPI BUTTES REGION

An Analysis of the Sherds and a Discussion of Similar Patterns in the Southwest*

(Accompanyied by 5 plates of drawings by Otilla A. Reagan.)

*Sherds were collected from each of these ruins separately and have been deposited in the Museum of Anthropology of the University of California at Second and Parnassus Avenues, San Francisco, Calif.

This work was undertaken in order to place the village sites of this region chronologically and also correlate them in age with the various other ruin-groups of the Plateau country. This necessitated the revisiting of the ruins in the Cornfields-Ganado region, a task which was not completed due to ill health of the writer. It is felt however, that potsherds were obtained from enough ruins to obtain a working basis for the correlation sought.

In doing this work the writer has followed both Kroeber and Spier. The reference works which he has at hand are: "Antiquities of the Jemez Plateau, New Mexico" (16), "Handbook of American Indians" (11), "Handbook of Aboriginal American Antiquities" (17,) "The Wisconsin Archaeologist'" (18), "Archaeological Reports of the Ontario Provincial Museum", Ontario, Canada, (19); "Zuni Potsherds" (20),, "Zuni Kin and Clan" (21), "An Outline of the Chronology of the Zuni Ruins" (C. Z. R.)* (22), "Notes on the Little Colorado Ruins"(23) "Ruins of the White Mountains, Arizona" (24), "Survey of the Southwest Zuni District" (25), "Pueblo Bonito" (26), "Designs on Prehistoric Pottery from Membres Valley" (27), "Two Summers Work in Pueblo Ruins" (Fewkes),* (8), Preliminary Report on a Visit to the Navajo National Monument" (Fewkes, Bull. 50*), (12), "Prehistoric

*These articles will be referred to later in the text by the word or abbreviation given here in parenthesis.

Villages, Castles, and Towers of Southwestern Colorado" (13), "Ancient Inhabitants of the San Juan Valley" (28), "Archaeological Explorations in the Northeastern Arizona" (K. & G.*) (9), The Basket Maker Caves of Northeastern Arizona" (10), "Archaeologicla-Research in the Northeastern San Juan Basin of Colorado During the Summer of 1921" (29), "The Fiedra-Parada Archaeological Field" (30), and "Casas Grandes Pottery" (31).

For further reference the reader should consult the bibliography in "Basket-Maker Caves of Northeastern Arizona", (10:pp. 119-121), in "An Outline for a Chronology of Zuni Ruins", (22:pp. 329-331), and that in "Handbook of Aboriginal American Antiquities", (17:pp. 368-372).

Two hundred and thirty ruins, including both cliff villages and villages in the open from the Tuba-Kayenta region, were described in my former reports, (see vol. 30, Trans. Acad. Sci. above), and two hundred and eighty from the Cornfields-Hopi Volcanic Buttes' field are described in this report. No analysis was made of the Tuba-Kayenta sherds, as they are considered "Kayenta culture" ware and left at that. An analysis of the sherds from the Cornfields-Hopi volcanic buttes area follows:

SLAB HOUSE TYPE

Black-on-White Series and Rough Dull-Gray Series, Without Slip. 0 to 10 per cent Corrugated (Slab-Huose Type) in the Typical Sites

No. 2. In pottery analysis this ruin divides itself into two sections, it being composed of an ea.t and west section. Moreover, pottery was obtained from the east section both before the big rains of this year and following them. These collections will also be considered separately, as 2w (west section) and 2E (east section), first visit; and 2E (east section) section) second visit.

No. 2w. (Plate A, Fig. 3, sherds 1-7.) One shiny painted sherd was found at this ruin. Two per cent of the ware was also found to be redware, which indicates that the site was occupied at two different periods.

Rough-Dull-Gray ware without slip. The ware here is all of the gray type and is noted for being rather thin, undecorated, dull, and rather rough, lacking a slip. No whole jars were found of this type and it may prove that these sherds are unpainted parts of black-on-white painted vessels. If such should prove the case, it would indicate that the larger part of the vessels were unpainted, as the sherds of this type are by far the most abundant about the site. A piece of a flat rock with crude carvings on it was found with these sherds.

Black-on-white. On the whole this ware is of the thin variety, in all characteristics like that of the rough-dull-gray ware above, except that it is decorated ware, and its black leans toward a brownish-black. Bowls are somewhat more common than jars. Bowls are decorated only on the inside, and the jars are of only medium size.

Three sherds bear a characteristic double spiral design somewhat like that of Fig. 11, k, of Zuni site 14 (C. Z. R.) and the Kayenta design on a sherd given as Pl. 54, j (K. & G.). Hachure work of the heavy type is the main design on several sherds, as is heavy parallel line and parallel bar work. One sherd bears a design like that of Fig. 14, i, of Zuni site 71, and one carries a design like that of Fig. 11, g, of Zuni site 14. One sherd carries a double, interlocking scroll work. Two carry double-lightning symbols between white and black bars; two carry Z-N patterns somewhat resembling those on the Kayenta slab-house pottery figured on Pl. 63 and Fig. 70 (K & G.). One sherd carries a single lightning design; two also carry diamond designs like the Kayenta diamond designs of Pl. 55, 23, 21, and 27 (K. & G.). One sherd also carries a design much like that of Fig. 15, c, of Zuni site 149 (C. Z. R.)

Black-on-Red. The sherds found of this ware were of jars only. The only characteristic design obtained much resembled that on the Zuni sherd, marked Fig. 14, i, of Zuni site 71 (C. Z. R.).

Corrugated. Fifty per cent of this ware is of the crude, slab-house type. The coils are frequently obliterated in part or entirely erased and then reindicated by incised lines. The necks of the jars also bear broad coils, often much flattened. Two sherds found also show ridges that were made with a stick or some other pointed instrument. The remaining sherds bear narrow corrugations, mostly of the indented type.

No. 2E. First visit). (Plate A, Fig. 3, sherds 8-21.) No corrugated ware and no red ware was found on this division of ruin 2 during this visit.

Rough-Dull-Gray ware, without slip. This ware is the most numerous ware about the site, comprising 60 per cent of the sherds, the remainder being black-on-white ware. These sherds are fragments of water and cooking jars, some having ears and loops for the attachment of straps, etc. The ware, as above, is undecorated, dull, lacking a slip, rather rough, and usually gray, although sometimes a black. Four blackish sherds of this type were found, one sherd being of a circular disk.

Black-on-White. The black of this series is more of a brownish-black on dull white (gray). The ware is thin and poorly slipped, like the black-on-white ware above. Three-fifths of the fragments are sherds of bowls.. One sherd is part of a jug, and the remainder are sherds of jars. The jug (pot) had a perforated knob on each side for the attachment of a carrying cord.

No hachure work in decoration was found. Most of the decorations are of the heavy type, mostly in parallel lines or triangles within triangles, like those in Fig. 11, f, of Zuni site 40 (C. Z. R.). One sherd has the characteristic checkerboard design in diamonds in white with a large, roundish black center, like those on some of the bowls from Four Mile Ruin (see Pl. 61 of Fewkes). One sherd has an hour glass design, in shape, surrounded by parallel lines. Several others are decorated with Z-N design patterns, like the Kayenta

PLATE A

Fig. 1: Pottery of the Slab-House Series.

Nos. 1 and 2 are sherds from Ruin 47a2; Nos. 3 and 4 are sherds from Ruin 47a3; Nos. 5 and 6 are sherds from Ruin 159; Nos. 7 to 9 are from Ruin 160; Nos. 10 and 11 are sherds from Ruin 167N-1; and Nos. 12-23 are sherds from Ruin 168.

Figure 2: Unclassified Sherds

Nos. 1-7 are from Ruin A-1 and are black-on-white ware; Nos. 8 and 9 are from Ruin 5; Nos. 10 and 11 are from Ruin 10; Nos. 12 and 13 are from Ruin 8; Nos. 14-18 are from Ruin 157.

slab-house ware mentioned above. One sherd has a lightning design in white, cutting the black band, in which it is enclosed into large opposite triangles. Another design seems to be a crude attempt at making some concrete figure, which can not now be made out.

No. 2E. (Second visit) No red ware was found on this visit, though one sherd has a reddish tinged pattern, and but one coarse corrugated sherd was found. The rough-dull-gray ware without slip (some having a reddish-sandy-grained tinge) was the same as that of the first visit as was the black-on-white ware. The latter was also dull and rough and seemed to have been made without slip, or poorly slipped.

One sherd had two ducks in black design (?), and another had an attempt at making some bird or butterfly. Another sherd had a design much like the design on the inside of the opening of the Kayenta vase, figured as Pl. 16, b, (Fewkes). The rest of the sherds are decorated with heavy parallel lines and bars and patterns like those of Fig. 11, f, and g, (of Zuni sites 14 and 40 (C. Z. R.). One reddish-brown unpainted sherd had also been made into a circular disk.

No. 17. (Plate A, Fig. 3, sherds 22-27.) From the appearance of the pottery, this village was occupied at least two different times. The ash heap south of the village gives numerous coiled sherds, and the center of the ruin gives as numerous an undecorated, coarse, dull, gray ware without slip. No red ware was found about the site.

Corrugated. About a sixth of the sherds bear plain, broad to narrow coils. A few sherds show both plain and indented coils, some of the narrow, indented corrugations being excellent work and some very crude. On the remaining sherds, the coils are frequently obliterated in part or entirely erased and then reindicated by incised lines, being of the slab-house type. Numerous sherds of plain vessels were also found, which will be considered as rough-dull-gray ware, without slip, below.

Rough-Dull-Gray Ware, Without Slip. Thirty per cent of this ware shows the use of slip. The remainder is of the true type, as given above.

Fig. 3: Pottery of the Slab House Series

Nos. 1-7 are from Ruin 2w; Nos. 8-21 are from Ruin 2E, and Nos. 22-27 are from Ruin 17.

Fig. 4: Unclassified Sherds from a General Assortment

Nos. 1, 2, 5, 6, and 9 are sherds of tops of jars. Nos. 2, 5, 6, and 9 are the inside of sherds. No. 1 is the outside of the sherd No. 2. Nos. 5 and 6 are black-on-red sherds.

No. 7 in Fig. 1 seems to be that of a horse and of recent time, apparently of Navajo origin. It was drawn on a piece of tuff but was found with the other sherds of the place.

Black-on-White (or Black-Brown-on-White). The principal decorations consist of areas, cross-hatched with fine to coarse lines in bold patterns, like those of Zuni site 24 and like those on the mug of Pl. 3 (Pueblo Bonito). A design very similar to that of Fig. 12, f, of site 24 above also occurs in the collection, as does a double spiral design like those of Fig. 11, k, of Zuni site 14 (C. R. Z.). Two sherds also have designs that somewhat resemble that of Fig. 14, b, of Zuni site 82. Another design is that of a broad, black, circular band with projecting dots without. Another design resembles those on the jar from Shumopovi of Pl. 48, 1, of Fewkes. Most of the other patterns are broad line work, and work similar to that on the bowls figured as Fig. 11, f and g of Zuni sites 14 and 40 (C. Z. R.).

No. 17 1-2. This is the flattened remains of a small village about 200 yards east of ruin No. 17. The pottery is of the same type as that of that ruin, except it appears to be earlier in age. The rough-dull-gray unslipped ware is 61 per cent of the whole. The designs on the black-on-white ware are principally of the hachure type, though some of the characteristic designs are like those of sites 14 and 40 of the Zuni ruins, as given by Spier. Ane one red colored sherd and 7 corrugated sherds were obtained.

No. 47. (About a mile northwest of Ganado there is a series of ruins which was designated as No. 47 in a previoius report. This series will here be considered according to its segments beginning with the southeastermost heap as 47a, 47a2, 47a3, 47a4, and 47a5, as follows:

No. 47a (the southernmost ruin of the 47 group). No corrugated ware and no red ware was found on this site.

Rugh-Dull-Gray Ware, Without Slip. Sherds of this type are the dominating ware, being 85 per cent of the whole. They are of the dull gray variety, are thin, unslipped, and roughly made.

Black-on-White. This is dull gray-white ware, roughish, and usually poorly made. One sherd carried a pattern of squares in white, another has a marginal pattern of triangles. Most of the other patterns are of the triangular type in heavy lines like those in Fig. 11, f, and g, of Zuni sites 14 and 40 (C. Z. R.).

No. 47a2. (Plate A, Fig. 1, sherds 1 and 2.) The pottery of this mound is very similar to that of ruin No. 47a. Ninety-five per cent of it is of the rough-dull-gray, unslipped series. Only two black-on-white sherds were obtained. Both of these had snake designs in white. The writer knows of no similar pottery designs, but these snake designs are very similar to those seen by him in the kivas at Jemez, New Mexico, and those seen in the same kivas by Simpson in 1850. They are also like certain snake drawings the writer often saw on the rocks about Kayenta and Marsh Pass. No corrugated ware was found.

No. 47a3. (Plate A, Fig. 1, sherds 3 and 4). The pottery of this site is the same as that of ruins Nos. 47a and 47a2.

No. 47a4. The pottery of this site is also the same as that of the rest of this series above. The collection includes a ladle handle.

No. 47a5. This is the north ruin of the group. The village was evidently not inhabited long, probably having been a watch tower-village. The pottery is scanty, only a gray piece and three corrugated sherds being obtained, though the rock mound of the village is quite a pile. The corrugated ware is of crude make.

No. 159. (Plate A, Fig 1, sherds 5 and 6). No red ware and no corrugated ware was found at this site.

Rough-Dull-Gray Ware, Without Slip. The sherds of this type at this village are coarse, roughly made, dull gray, undecorated ware without slip, like that previously described and comprises 95 per cent of the sherds about the site.

Black-on-White (gray). The sherd obtained was identical in make with the rough-dull-gray pottery above, but was decorated in a black "pole with a cross bar", very crudely made.

No. 160. (Plate A, Fig. 1, sherds 7-9). No red ware was found about this site.

Corrugated. The sherds of this type are too few for characterization.

Rough-Dull-Gray Ware, Without Slip. This ware is similar to that described under ruin No. 159.

Black-on-White. Fifty-seven per cent of this ware is the same as the black-on-white ware of ruin No. 159. The remaining ware is mostly of the heavy, parallel bar type, some of the patterns resembling those of Zuni sites 14 and 40, as given by Spier.

A drawing of a quadruped, deer or antelope, was found on a slab of tuff among the above sherds.

There seems to be evidence that this site was occupied at two different periods.

No. 167n-1. (Plate A, Fig. 1, sherds 10 and 11). The potsherds found are also of the very earliest Zuni type. No red ware found.

Corrugated. Eighty per cent of this ware is reminiscent of the slab-house type.

Rough-Dull-Gray Ware, Without Slip. This is the same ware we have met with above.

Black-on-White. Twenty-five per cent of this ware is early Zunian type.

No. 167n-2. (Plate E, Fig. 3, sherds 6-14). Only one red painted sherd was found at this site.

Corrugated. Forty-four per cent of this ware is slab-house type of pottery, and the remaining sherds bear somewhat narrow, indented corrugations.

Rough-Dull-Gray Ware, Without Slip. The sherds found here are similar to those of this ware previously described.

Black-on-White. Thirty-four per cent of this ware is of the early Zunian type of black-on-white ware, the same as is always found with the rough-dull gray ware, without slip. The remaining sherds are also of early Zunian type in make and decoration. Of the designs of the latter, eight sherds bear hachure patterns, one pattern resembling Pueblo Bonito hashure ware patterns. One sherd carries a design

very similar to that of the "white diamonds" Pl. 16, b, on a Kayenta vase with constricted neck (Fewkes, Bull. 50). One sherd bears a dotted figure that looks like it might be a part of a dice-drawing The other designs used are similar to those of ruin 167n-1. The designs of the former group are of the slab-house type, many being like those of Fig. 11, f, and g, of Zuni sites 14 and 40 of Spier.

No. 168. (Plate A, Fig. 1, sherds 12-23). No red ware was found at this site.

Corrugated. Sixty-four per cent of the sherds of this class are of the slab-house type. The remaining sherds bear narrow corrugations, both plain and indented.

Rough-Dull-Gray Ware, Without Slip. This ware is similar to the ware previously described under this heading, except it is made better from a better clay mixture and has also been "slipped", though a few coarse unslipped sherds occur in the collection. These sherds may prove to be bottoms of black-on-white vessels.

Black-on-White. There are three suspended spirals in the decorations and two double spirals like those in Fig. 11, i, and k, of Zuni site 14. Three sherds bear hachure designs; three carry interlocking scrolls almost like the Kayenta scroll patterns of Fig. 60, b(K. & G.), but in reverse order. Several sherds carry the white squares (diamonds) with black circular centers, like the Kayenta diamonds (and squares) of Pl. 55, 21 to 30 (K. & G.). There are also several lightning-snake patterns. The other patterns are mostly of the heavy line type, characteristic of the early Zunian ware.

No. 170. (Plate B, Fig. 3, sherds 1-4). This is a ruin near Bob Mahan's place at Kinna Zinde. No red ware was found about this site. The black and white pottery obtained has the appearance of being of early type, as does the corrugated ware, which opinion is strengthened by the large perecentage (27 per cent) of rough-dull-gray ware, without slip. Considerable of the corrugated ware is of crude workmanship and of erased and lated incised work, while with the black-on-white ware one-fifth of the designs are of hachure work, much like that on the Zuni bowl, marked "a" in Fig. 15, p. 321 (C. Z. R.). One sherd has a broken line, interlocking scroll design. One bowl sherd has a circular, black band circling its center, from which dotted knobs project inward. Another sherd has a design much resembling that on the Kayenta food bowl, given as Pl. 15, a, of Fewkes (Bull. 50).

Ruins Nos. A, AE, A6, A7, A8, 46, 64M (?), 64L (?), 100, 166 and 169 also have a percentage of slab-house pottery, but, as these ruins also carry pottery of later types, they were undoubtedly occupied during two or more different periods.

From the above analysis it will be seen that the typical slab-house sites are ruins Nos. 2E, 47a, 47a2, 47a3, 47a4, 159 and 160 above, the corrugated ware here ranging from 0 to 5 per cent.

PIT DWELLING TYPE (Black-on-White Series).

Corrugated ware 15 to 46 per cent. No red ware.

These ruins are called pit dwellings because they are dwellings of that type, hence the pottery is considered as the Pit-Dwelling Type.

No. 164. (Plate B, Fig. 3, sherds 5-8). This number represents a series of pit ruins 5 miles southeast of Cornfields Day School. Their pottery is as follows:

Corrugated. Sixty per cent of the sherds obtained were coarse, crudely made ware, reminiscent of the slab-house type.

Black-on-White. Three sherds carry interlocking scrolls, much like those of Fig. 78 and 81 on bowls from Kintiel (Fewkes), also somewhat resembling Kayenta interlocking scrolls of Pl. 55, g, (K. & G.), but more like the interlocking scroll pattern of Fig. 16, m, of Zuni site 33 (C. Z. R.), but in reverse order. One sherd also has a double coil design very much like that of Fig. 11, j, of Zuni site 14, but in reverse order. The other patterns obtained are mostly of the heavy line, parallel bar order.

No. 165. (Plate B, Fig. 3, sherds 9-11). This is the only other ruin of this type of village that was examined, though there are probably hundreds of such ruins in the thinly timbered sections of the middle mesa region. The pottery found at this site is as follows:

Corrugated. The sherds of this ware that were obtained at this site are of the slab-house type of corrugated ware.

Black-on-White. One pattern obtained is like that of Fig. 12, p, of Zuni site 164 (C. Z. R.). A sherd also carries a pattern very similar to that of Fig. 11, j, of Zuni site 14 (C. Z. R.). One hachured design was obtained and one pattern of the dotted triangle-pattern. One roughly made sherd also has a chicken track pattern. The other patterns are very similar to those described under ruin No. 164.

Black-on-White Series. Red ware is not represented in this series, neither is the shiny painted ware, nor the rough-dull-gray ware, without slip, except at ruin No. 166, which is doubtfully classed in this group.

No. 8. (Plate A, Fig. 2, sherds 12 and 13.) Corrugated. Seventy-nine per cent of this ware is of the slab-house type, like that of Zuni sites 14 and 40 of Spier (C. Z. R., p. 306, and Fig. 11). The remainder is of a better made type, much like that of Zuni site 24 (p. 308 above).

Black-on-White (The designs are more of a brownish black on grayish white). Of the 71 pieces of this ware obtained 16 are unmarked gray-white ware, probably representing bottoms of cooking jars. They all show slip work and, though coarse, they do not resemble the rough-dull-gray ware without slip of earlier sites. Nine of the marked pieces of this ware show hachured patterns. One shows a toothed triangle like those of Fig. 12, p, of Zuni site 164, and another sherd has a double spiral design like that of Fig. 11, i, of Zuni site 14 (C. Z. R.). The other designs obtained are not characteristic. It might also be mentioned that one sherd is the half of a large dish which had a hole in its center.

No. 9. (Plate B, Fig. 3 sherds 16-18). Corrugated. Eighty-five per cent of this ware is of the slab-house type. The remaining sherds bear more or less narrow corrugations, but mostly more or less re-

PLATE B

Fig. 1: Two-Color Painted Ware

Nos. 1-5 (1 and 2 are black-on-red) are from Ruin A-5; Nos. 6 and 7 are from Ruin A-10; No. 8 is a sherd from Ruin A-10 3-4c; 9 and 10 are sherds from Ruin 33S; Nos. 11 and 12 are from Ruin 33N; Nos. 13 and 14 (No. 13 is the outside of a pot and 14 the inside, both being painted black-on-orange) are from Ruin 46; Nos. 15-17 are sherds from Ruin 50, and Nos. 18 and 19 are from Ruin 51.

Fig. 2. Two-Color Painted Ware.

Nos. 1-9 are sherds from Ruin 51; Nos. 10-14 are from Ruin 53, and Nos. 15-18 are from Ruin 54.

(Concluded on next page, bottom.)

miniscent of the slab-house type in appearance, though a few show well made, narrow indented coil work.

Black (brownish black)-on-White. Twenty-four per cent of this ware is undecorated, smooth, gray ware with slip, apparently the bottoms and sides of pots of black-on-white make. They do not at least have the appearance of the earlier, rough (coarse)-dull-gray ware without slip, of the earlier sites of the region. Thirty-three per cent of the white-on-black ware is of hachure type, much resembling that of Pueblo Bonito, some also resembling the Kayenta hachure patterns, and some also resembling the hatched design on Fig. 18, a, from a ruin southwest of Zuni (C. Z. R.), though no sherd carries a pattern exactly any pattern figured from any of these regions. Of the remaining sherds, one carries a double coil design exactly like that of Fig. 11, k, of Zuni site 14 and that of Pl. 54, j, of Kayenta (K. & G.). Another sherd carries a step design like that of Fig. 14, i, of Zuni site 71, except that the hachure work beneath the Zuni step figure is lacking. One sherd has a pattern that approaches a glaze. A sherd also carries a series of broad, double-toothed-comb designs between broad white bands, bordered with a wide black line on each side. Another carries a series of alternate, black and white, flag-like triangles in concentric bands. The remaining patterns are principally of the heavy-line, parallel band type.

The pottery of this site and that of ruin No. 8 is undoubtedly of early Zunian type, though later in age than the slab-house type.

No. 34. Corrugated. All the sherds obtained of this class were of the slab-house type.

Black-on-White. No characteristic patterns were obtained.

No. 46. (First visit.) (Plate B, Fig. 4, sherds 1-4.) Corrugated Most of the sherds bear narrow indented coils, except from the plain rim section.

Black-on-White. Hachure ware is the predominant ware of this class, some of which resembles the hachured designs on Fig 18, a, of Zuni (C. Z. R.). On the other hand they are all very similar to the

Fig. 3: Pottery of the Slab-House Type

Nos. 1-4 are drawings of sherds from Ruin 170.

Pit-Dwelling Type

Nos. 5-8 are sherds from Ruin 164 and Nos. 9-11 are from Ruin 165.

Black-on-White Series

Nos. 12-15 are sherds from Ruin A-8, and Nos. 16-18 are sherds from Ruin 9.

Fig. 4: Black-on-White Series

Nos. 1-4 are sherds from Ruin 46 (first visit); Nos. 5-7 are from Ruin 52; No. 8 is from Ruin 55; Nos. 9 and 10 are from Ruin 76; Nos. 11 and 12 are from Ruin 82; No. 13 is from Ruin 163; and Nos. 14 and 15 are sherds from Ruin 171.

hachured work on the cylindrical jar from Pueblo Bonito, figured on Pl. 3, (Pueblo Bonito).

Note. A round turquoise bean was found at this ruin.

No. 52. (Plate B, Fig. 4, sherds 5-7). Corrugated. Indented, narrow corrugations covering the vessel with the exception of the plain rim, mark the prevailing form. A few sherds show plain, narrow coils, without indentations.

Black-on-White. Four sherds of this type of ware had been made into dice. Two sherds bear saw-toothed designs, very similar to the saw-toothed design of Fig 12, f, of Zuni site 24 (C. Z. R.). A sherd bears a triangular, notched design in black, much like the notched triangular design of Pl. 61 of a food bowl from Four Mile Ruin, Arizona (Fewkes), and another has a cross-cut saw design very similar to the cross-cut saw pattern on the vase from Shimpovi, Arizona, marked Pl. 50, b, (Fewkes). A great part of this (black-on-white ware (30 per cent of it), however, is of the heavy line, bar work, usually of the parallel type. The remainder, with the exception of the sherds first mentioned under this subject, is hachured ware, compromising 64 per cent of the whole. The hachured ware all closely resembles the hachured ware from Pueblo Bonito, many sherds having designs practically identical with that on the cylindrical bowl from that pueblo, figured as Pl. 3 (Pueblo Bonito). Some patterns also approach the hachured designs shown on the pitcher, figured as Fig. 18, a, from a ruin southwest of Zuni (C. Z. R.).

No. 55. (Plate B, 4, sherd 8). The corrugated ware is mostly of the slab-house type, Sixty-two per cent of the black-on-white ware is of the hachure type of design, much resembling both Pueblo Benito and Kayenta ware, but favoring the former the most. The other sherds are too few for characterization.

No. 69 3-4 (the upper mound of the 69 series).

Corrugated. Fifty per cent of the sherds bear plain, broad, or coarsely indented coils, reminiscent of the slab-house type. The remaining sherds bear narrow corrugations of the indented type, except for a plain flaring rim.

Black-on-White. One sherd carries a design which is in part like that of the "white diamonds" on the Kayenta pot, figured as Pl. 16, b, of Fewkes (Bull. 50). A few sherds carry hatched work in design. Three sherds carry dotted figures, two of which approach the dotted triangle pattern. The other designs are all of the heavy, parallel line and bar type.

On the whole the pottery of this ruin resembles that of Zuni site 24 (C. Z. R. pp. 224 and 308).

No. 76. (Plate B, Fig. 4, sherds 9 and 10). Corrugated. The vessels of this type were normally entirely covered with narrow corrugations, except for a plain flaring lip. One sherd of this ware is also decorated in black and white parallel bars on the inside, the corrugations also having been mostly erased without.

Black-on-White. One-half of this ware is decorated in hatched

and cross-hatched designs, which closely resemble the hatched patterns of Pueblo Bonito, Zuni, and Kayenta; but there appears to be no design exactly like any listed from any of those regions. Besides the hatched decoration, one sherd also bears a dotted-bar pattern, somewhat resembling the bark figures on the Kayenta pot, figured as Pl. 18, b, (K & G). Of the remaining black-on-white sherds from this ruin, five are undecorated, one of which had been made into a pot smoothener. One sherd had toothed triangles in design. One had parallel lines surrounding a square figure. One has parallel lines of projecting cones in brown. Another has a dotted triangle like those on the sherd figured as Fig. 12, p, of Zuni site 164 (C. Z. R.). The remaining designs are mostly heavy line work of the parallel type.

No. 82. (Plate B, Fig. sherds 11 and 12, and Plate C, Fig. 1, sherd 5). Corrugated. Sherds of this type are too few for characterization.

Black-on-White. Twenty per cent of this ware is of the hatched type in decorative design. One sherd is decorated in a heavy line design which is similar to that of the bowl which is figured as Fig. 14, b, of Zuni site 82 (C. Z. R.). Another sherd has a saw-toothed figure somewhat similar to that of Fig. 12, f, of Zuni site 24. One sherd has a dotted triangular design like that of Fig. 12, p, of Zuni site 164, and another carries a checkerboard pattern in white, set in a background of shiny black. One sherd has also been made into a disk.

No. 163. (Plate B, Fig. 4, sherd 13). Only one sherd, a black-on-white painted bottom of a food vessel, was obtained from this ruin. It had a central, whorled pattern of inverted F's, surrounded by parallel bars, within and surrounding the center of the bowl.

No. 166. This ruin is opposite Carrigan's store at Ganado. No shiny painted ware and no red ware was represented. Only one corrugated sherd was found and one black-on-white fragment was obtained. The seven other sherds obtained were of the rough-dull-gray ware, without slip, which shows that the ruin corresponds in age to the early Zuni sites of Spier.

Note. This site is doubtfully placed in this list, as its large percentage (80 per cent) of rough-dull-gray ware, without slip, would seem to place it in the slab-house type series.

No. 171. (Plate B, Fig. 4, sherds 14 and 15, and Plate C, Fig. 3, sherd 19, which is of slab-house type). Only two corrugated sherds were obtained and they were both of crude make. The remainder was black-on-white ware, though one piece was undecorated. One sherd had a double spiral like that of Fig. 11, k, of Zuni site 14 (C. Z. R.), and like that of Pl. 54, j, from Kayenta (K. & G.). One sherd carried step designs resembling those of Zuni. Another potsherd carried an elaborate double lightning series between converging parallel lines. And so on. It might be added that most of the pottery obtained was from a grave that is being exposed in a canyon at the village.

No. A1. (Plate A, Fig. 2, sherds 1-7). Corrugated. Sixty-five pieces of this ware were obtained. One sherd is a piece of a carrying jug, having a knob and a hole for the attachment of a strap. The rest are apparently sherds of jars. Two pieces had been smoothed and then deeply marked with some sharp instrument in long cuts incised in broad V-shaped cuts. Three were just straight-ridged. Six were tops of jars and were smooth, as was the piece with the knob. Sixty-six per cent of the remainder are sherds on which the coils are broad and very poorly made, the coils sometimes showing in wavy effect only. The work on these sherds is crude in every way. The remaining sherds grade from coarse work to narrow, indented coils, except for a plain flaring rim. The workmanship shows that this village was inhabited for a long period of time, the weathering down of the ridge-bench now exposing the pottery of the whole series from top to bottom of the refuse heap and house sites. Ancient graves are also laid bare as will be noted later. Sixty per cent of this corrugated ware is of the slab-house type, as figured and described by Spier and by Kidder and Guernsey.

Black-on-White. Thirty-eight per cent of this ware is undecorated, rough-dull-gray pottery, without slip, one piece of which had been used as a smoothener in making other pots. Twenty-five per cent of the pieces show hatched work. A large per cent of the remainder is heavy, broad line work.

One whole jar obtained is of elaborate hatched pattern throughout. One part of this pattern is composed of hatched points like the points of the design on the mug represented on Pl. 3 (Pueblo Bonito). One whole bowl obtained has a notched, interlocking pennant-design in double sets, extending from straight lines, somewhat resembling the pattern of the bowl Pl. 61, b, of Fewkes. A jug obtained has hatched lines all over it to exaggeration, reminding one much of the hatched designs on several of the Pueblo Bonito pots. Fragments of two other jugs in the collection have similar patterns.

Of the other designs, one sherd has a design very similar to the notched design (single triangle) pattern of Pl. 31, b, on a vessel from Homolobi (Fewkes), and the single triangle pattern of Fig. 59, a, (K. & G.). Diamond shaped patterns occur on several sherds. One ceremonial bowl obtained is decorated wholly in pennant triangles, 26 flag-lines of connected triangles in black zigzags from the opening at the top of the bowl over its side to the bottom, making an angle where the flattish top of the bowl meets the body and another angle along the "equitorial" line of the body wall, much resembling the pattern of the sherd, figured as Fig. 12, m, of Zuni site 164 (C. Z. R.), but running in the vertical instead of the horizontal as in that pattern. One jug (much broken), has duplications of the double saw design of Fig. 12, f, of Zuni site 24, except it is black-on-white instead of black paint-on-red. Another sherd has an interesting scroll design much like that of Fig. 78 from Kintiel (Fewkes), but in reverse order. Squares and diamonds show in design, as also does diamond-shaped squares in white with central black dots, like those

of Pl. 55, 22 (K. & G.). Another design seems to represent a bird.

No red ware or shiny black-on-white ware was found at this ruin.

Eight skeletons were exposed at this site. Seven of them and the skeleton of a dog were found piled close together. One male skeleton had its hands outstretched. On the whole the skeletons all had the appearance of having been thrown into a hole or room—not properly buried. One man had had his skull crushed in. It would seem that they had been killed in battle or a massacre. This conclusion is strengthened by the fact that no bowls or artifacts of any kind were found with the bones where the seven skeletons and the dog skeleton were found. Thirty feet north of this grave the bones of a man were found that had been properly buried. He had been placed on his back, facing the setting sun. His arms were folded. On his left side just below his arms were a food bowl and a water jug, and in a similar position on his right side there was a ceremonial bowl, containing a yellow ochre paint stone and 29 pieces of turquoise. Another jug had also been buried with this body, but, being exposed, a Navajo boy destroyed it.

When this skeleton was discovered, its lower extremities were exposed as was a considerable part of the other skeletons. All of these skeletons were reinterred in a better burial on the site.

Note. The evidence adduced from the pottery of the state of the ruin shows the village, or series of villages, to be very old. It also shows that its earliest settlers were not much advanced beyond the slab-house stage. Its absence of red and shiny black-on-white ware also shows it to be much older than ruin No. A and its suburban ruins AK 1-5.

TWO COLOR PAINTED WARE SERIES

Rough-dull-gray ware, without slip, is not represented in this series, neither is the shiny painted ware, nor the three-colored painted ware. Red ware is represented, as is buff ware occasionally, the per cent of each of which will be given immediately following the village number.

No. A5. (Plate B, Fig. 1, sherds 1-5). Five per cent red ware.

Corrugated. The sherds of this type are all fragments of jars, seeming to be mostly of small-sized jars. The jar tops are not corrugated. One sherd is of the dark variety. One-half of the sherds are of the slab house type, the coils being flattened, rubbed off, or poorly made. The coils on the remaining sherds bear narrow corrugations mostly of the indented type; one piece of the latter was painted black and white on the inside. In general, the corrugated ware resembles that of site 24 of the Zuni ruins (C. Z. R.) above.

Black-(brown-black)-on-White, the white sometimes having a yellowish cast, and the black, a brownish tinge. Bowls constitute three-fifths of the forms, among which are a ceremonial bowl of the dead, a crude unfinished bowl, and a sprinkling, ceremonial bowl. The decorations here differ much from any previously found in the region. Thirty-five sherds show part coarse hatched work. The design on one sherd is like that of Fig. 12, c, of Zuni site 24 (C. Z. R.). An-

other pattern very much resembles that of Fig. 12, n, of Zuni site 164 of the same series. Three sherds have designs somewhat like the deigns on the Kayenta sherds figured as Fig. 60, a, and b, (K. & G.), the scroll designs on the globular bowl from Kintiel (Wide Ruin), figured on p. 131 as Fig. 78 of Fewkes. The decoration on one piece very much resembles that of Fig. 14, b, of Zuni sites 81 and 82 (C. Z. R.), and another that of Fig. 14, i, of the same series, the sherd that contains the latter being part of a sprinkling, ceremonial bowl. One design is that of a whitish triangle in series, surrounded by black triangles, all of large size. Another design is of variously shaped figures in white, dotted in black, giving a pepper-and-salt effect. The other designs are of heavy bars, bands, and lines.

Black Paint-on-Red. The sherds from this ruin bearing this type of decoration are too few for characterization.

In conclusion., the sherds and decorations on same would seem to place the age of this ruin apparently with that of site 24 of the Zuni ruins (C. Z. R., p. 308), though the pottery seems to indicate two periods of occupancy.

No. A7. Six per cent red ware. Corrugated. Only medium sized jars are represented, one-seventh of which are of the dark colored ware type, the remained being the usual gray in color. Four sherds are tops of jars, three of which show rough corrugations. Fifty per cent of the sherds had the coils obliterated in part or entirely erased and then, in a few cases, reindicated by incised lines which were made with a sharp pointed instrument. Plain vessels also occur, as does broad coiled and coarsely indented coiled ware. Three coils also, have narrow, straight-coil lines. Others bear narrow, partly well made, indented coils. On the whole the work is crude and rough and is hardly superior to that of the slab-house type.

Black-on-White. Bowls are a little more numerous than jars. The vessels are decorated only on one side. One design is like that of 11, k, of Zuni site 14 (C. Z. R.). Two sherds are of the checker-board type in pattern of design, the sources being in white. Coarse hatched designs also occur on several sherds. The other patterns are not characteristic, except for occasional bands and wavy lines.

Black Paint-on-Red. Sherds of this type are too few for characterization.

No. A8. (Plate B, Fig. 3, sherds 12-15). Five per cent red ware.

Corrugated. The corrugated ware of this village is similar to that of ruin No. A7.

Black-on-White: the black often being a blackish brown. One sherd is decorated with the characteristic design of the region, very similar to that of Fig. 11, k, of Zuni site 14 (C. Z. R.), but more nearly like that of the Kayenta sherd, shown as Pl. 54, j, (K. & G.), a double spiral design, but while similar yet quite unlike the San Juan design as given on Pl. 22 (San Juan Ruins), as it has not the radiating points. The design on another sherd also somewhat resembles the dotted triangular design in the upper, right hand corner of the same plate (San Juan Ruins). It also more nearly resembles

the dotted triangular designs on the bowl, figured as the lower figure of Pl. 61 from Four Mile Ruin, Arizona, (Fewkes). Another sherd of a bowl has a design on it very similar to that on the bowl, figured as Pl. 37, b, from Chevelon, Arizona, (Fewkes). One sherd of a bowl has a checkerboard design, the squares being white with blackish, roundish centers like the Kayenta designs, shown as Pl. 55, 23, and 29. Another sherd has a saw-tooth design much resembling the saw-toothed design on sherd 23 and on sherd 30 of the same plate (Pl. 55, 23 and 30—K. & G.). One design on a whiter sherd than the others is of a wavy nature, like the wavy triangle series shown on a food bowl from Chevelon, Arizona, (Pl. 39, b, of Fewkes). Another design closely resembles the Zuni design in step-figure given as Fig. 15, i, from site 149 (C. Z. R.), except the lines are many times heavier. No hatched patterns were obtained.

Note. A large fragment of a late or recent Zuni pot was found in a sand dune blow-out on a ridge one-half mile about due south of this ruin and about the same distance west of ruin No. A-1.

No. A 10. (Plate B, Fig. 1, sherds 6 and 7). One per cent red ware. The sherds here considered are from ruin No. 10 and a small house ruin of the same type, a very small ruin, marked X, situated one-fourth of a mile nearly east of A-10. Only one red painted sherd of the black paint-on-red type was found, that of a bowl, decorated on the inside in heavy, parallel bands.

Corrugated. The corrugated ware is practically of the same type as that of Zuni sites 14 and 40 (p 306, C. Z. R.), which are designated as "slab-house type", the main difference being that some of the jars have rounded (curved) necks. For the most part, the coils are obliterated or flattened and then reindicated by incised lines. On some of the sherds the coils are entirely erased, and lines incised in various directions with a sharp stick or other pointed instrument. Others have been "heavily" ridged in the same way. A few of the sherds are also coarsely indented ware. No sherds with narrow indented coils were found.

Black on-White. Bowls constitute about three-fifths of the forms. More than one-fourth of the decorations are heavily crosshatched work. Some wavy triangles also show in decoration. An interlocking scroll, much like those on the globular bowl from Kintiel (Fig. 78, p. 131 of Fewkes) and some of the Kayenta interlocking scrolls (given on Fig. 56, p. 131 of Kidder and Guernsey) occurs on several sherds.

No. 10 3-4, (a, b, and c). The ruins represented by this number are on top of the mesa about a mile east of the ruin A-10, running in a north and south line along the crest of the ridge. All of them are small, the middle ruin (b) having been only a two roomed affair. Moreover, no pottery was found at it. The distance between ruins a and b is about one-fourth of a mile. The other two ruins are considered separately below.

No. 10 3-4: Red ware one per cent or less. This ruin is of the small house type. It has two piles of rock, representing ancient stone segments, the northern segment being the larger heap. East

of the latter is quite a depression, east of which is the remains of the refuse heap, now quite a mound.

Sixty per cent of the pottery found at this ruin is corrugated ware. 61 per cent of which is of the slab-house type. The other corrugated sherds bear narrow, well made indented coils, except from the plain rim section. The designs on the red ware and the black-on-white ware are non-characteristic and are not of a determining factor in classification.

No. 10 3-4c. (Plate B, Fig. 1, sherd 8). Red ware 1 per cent or less. The pottery of this ruin is very similar to that of ruin No. 10 3-4a. Of the black-on-white ware, one interlocking scroll design was obtained. It was a little like that of the globular bowl from Kintiel (Fig. 78 of Fewkes), but in reverse order. Two sherds have the diamond design with circular, central dotted centers like those of Pl. 55, 21, 23, 24, 27, 16 and 28 of the Kayenta series (K. & G.). Another design is a double spiral like that of Fig. 11, k, of Zuni site 14 (C. Z. R.), with the exception that it has notched edges. The sherd which carries this design, also has a notched knife blade pattern.

No. 33. This ruin, as previously described, is composed of a north and a south village mound. In this work the pottery of each of these will be considered separately.

No. 33. (North section). Plate B, Fig. 1, sherds 11 and 12). Seven per cent red ware.

Corrugated. The few sherds obtained are all of the reminiscent slab-house type.

Black-on-White. Considerable hatched work occurs in the patterns, as does heavy line and band work. Another conspicuous set of decorations is that of elongated, horizontal triangles with projecting knobs on the hypothenuse side in reverse but similar order to those of Pl. 61, b, on a food bowl from Four Mile Ruin (Fewkes). Another sherd has a design in alternate black and white triangles, diagonally set to a series of saw-toothed figures, somewhat resembling those figured from Kayenta (Pl. 55, 13, 14, 15, 16, 20, and 23—K. & G.) and that on the Zuni sherd, Fig. 14, h, from site 71 (C. Z. R.). The designs on the whole, however, are not characteristic.

Black Paint-on-Red. The sherds of this type are too few for characterization.

No. 33. (South section). (Plate B, Fig. 1, sherds 9 and 10). Five per cent red ware.

Corrugated. The sherds obtained of this class were of the slab-house type.

The black-on-white and the black paint-on-red ware are covered by the remarks on those classes under North Section of ruin No. 33.

No. 45n. Plate C, Fig. 1, sherd 6). Six per cent red ware. Exposed debris of a village across a side wash 300 yards north of ruin No. 45 is here designated as ruin No. 45n.

Corrugated.* Vessels are normally covered with narrow indented corrugations, except the flaring lip part, which is usually plain.

There are also some coarse, corrugated-indented ware. Some of the best corrugated indented ware yet seen in the region was also found at this site. One corrugated sherd was also painted in black-on-white, the pattern somewhat resembling that of Fig. 14, b, of Zuni sites 81 and 82 (C. Z. R.). Four corrugated sherds were also darkish in color.

Rough-Dull-Gray Ware, Without Slip. The ware of this type had been more or less smoothed, had a less dull color, and was not so coarse in make as that previously described, and is of later make than the true slab-house pottery.

Black-on-White. The designs found on the pottery of this type are not characteristic.

Black Paint-on-Red. Sherds of this type are too few for characterization.

No. 46. (Second gathering of pottery, the pottery having been uncovered by storms, winds, and floods.) (Plate B, Fig. 1, sherds 13 and 14). Two per cent red ware.

Corrugated. Thirty-two per cent of this ware is of the slab-house type. The remainder is entirely covered with narrow, indented coils, except for the plain flaring rim.

Rough-Dull-Gray Ware, Without Slip. Sherds of ths type occur in the collection, which, with the slab-house type of corrugated ware obtained, show that this ruin was occupied at different periods. A few sherds of this ware are also of the late type. It might also be added here that along with the gray ware there was found a dice that had been made out of a flat slab of rock.

Black-on-White. Fifty-nine per cent of this ware is of the hatched type in design, much resembling Pueblo Bonito ware, also Zuni and Kayenta ware of this type. Two per cent of the ware is of the dotted triangular type. A double spiral also forms part of the decoration of one sherd. In form it somewhat resembles the "Y" figures on the food bowl of Pl. 25, b, from Four Mile Ruin, Arizona, of Pl. 29, b, from Chavez Pass, of Pl. 47, b, from Chevelon, Arizona, and of Pl. 64, also from Four Mile Ruin (Fewkes). The other designs are not conspicuous or characteristic.

Black Paint-on-Red. (Including Brown-on-Buff Ware.) The sherds of these type are too few for characterization.

No. 50. Plate B, Fig. 1, sherds 15-17). Two per cent red ware.

Corrugated. On the whole the sherds generally bear narrow, indented coils, except from the plain rim section.

Black-on-White. Twenty per cent of this ware is of the hatched type, like the Pueblo Bonito hatched ware, though there are no exact patterns. Several sherds have dotted triangles, somewhat resembling those on Pl. 22 (Archaelogical Research in Southwestern Colorado), on the food bowl from Four Mile Ruin, Arizona, lower figure, Pl. 61, and that of Pl. 48, b, from Shumopovi, Arizona, (Fewkes). One also has a saw-toothed figure like the crosscut sawtoothed figure of Pl. 50, b, on a vase also from Shumopovi (Fewkes). A sherd also has what appears to be the body of a bird inclosed in parallel bars and lightning-step designs.

Black Paint-on-Red. Sherds of this type are too few for characterization.

No. 51. (Plate B, Fig. 1, sherds 18 and 19 and Fig. 2, sherds 1-9). Six per cent red ware.

Corrugated. For the most part the ware of this type from this village is well made, narrow, both plain and indented coils.

Black-on-White. One of the sherds obtained is a handle of a jar. Forty-five per cent of the sherds collected of this ware have hatched designs, closely resembling the designs on pottery from Pueblo Bonito, one design being an exact pattern of that on the cylindrical jar, figured as Pl. 3 (Pueblo Bonito) and on a mug figured on Fig. 70 from the same place. Another sherd has a design very similar to the Z design of the food bowl of Fig. 49 of Pueblo Bonito, but in reverse order. Another sherd has a pattern-design like that on the Zuni sherd of Fig. 12, k, of site 164 (C. Z. R.). One sherd carries an interlocking scroll design. Another carries an inch-band of large X's in black between black lines. Another carries a checkerboard design in black and white. Another has the spaces, usually occupied by hatched work, filled with checkerboard patterns like that of Fig. 13, g, of Zuni site 86 (C. Z. R.). Another has hachure work and cloud-effect designs, and another carries notched knife blade designs. Other designs are heavy line and parallel band work.

Black Paint-on-Red. The red ware found has very plain designs, mostly of the parallel type.

No. 53. (Plate B, Fig. 2, sherds 10-14.) Two per cent red ware. The large size of the refuse heap (earth-mound) in comparison with the size of the ruin, together with the abundance of sherds about its site and especially about the earth-mound, indicate that the site was occupied for a long period of time, probably for hundreds of years.

Corrugated. This ware, on the whole, is similar to that of ruin No. 50. Several sherds, however, show very poor work, reminiscent of the slab-house type.

Black-on-White. (Including three Brown-on-White sherds.) The black of this ware often has a brownish tinge. Seventeen per cent of the sherds obtained are of the hatched type of design, resembling Zuni, Pueblo Bonito, and Kayenta ware, though there is but one exact pattern, an exact duplicate of that of Pl. 55, 3, of Kayenta (K. & G.). A sherd has a design very similar to the diamond designs in gray on the Kayenta vase, given as Pl. 16, b, (K. & G.), Two sherds have double spiral designs like Zuni design Fig. 11, k, of site 14 (C. Z. R.) and the similar Kayenta design given as Pl. 56, j, (K. & G.) Two sherds shary a double series of triangles. Two carry dotted triangles and one an interlocking scroll in white, much resembling the Kayenta interlocking scroll of Fig. 56, b. A sherd carries a design very similar to that of the sherd, figured as Pl. 55, 4, from Kayenta (K. & G.). Two sherds carry designs like the extended index finger and thumb along side of it, almost like the extended finger design on the vase of Pl. 30, a, from Homolobi, Arizona, (Fewkes). Most of the other sherds carry designs of heavy, more or less parallel lines and bands.

Black Paint-on-Red. Remarks on whis ware under ruin No. 50 apply.

No. 54. (Plate B, Fig. 2, sherds 15-18, and Plate C, Fig. 1, sherd 1). One per cent red ware.

Corrugated. The ware of this type, on the whole, is of fair make, though some of it is of a make reminiscent of the slab-house type.

Black-on-White. Thirty-four per cent of this ware is of the hatched type in design, somewhat resembling the design on the cylindrical jar from Pueblo Bonito of Pl. 3 (Pueblo Bonito), and also much of the Zuni hatched ware, one sherd having a design exactly like the hatched patterns on a jar figured as Fig. 18, a, from a ruin southwest of Zuni (C. Z. R.). Two sherds carry double spiral designs like that of Fig. 11, k, of Zuni site 14. Four sherds have cross-cut saw-toothed designs very much like the saw-toothed designs on a vase from Shumopovi (Pl. 50, b, of Fewkes. Two sherds also have triangular designs somewhat resembling those on the food bowl from Four Mile Ruin, Arizona, figured as Pl. 61, b, of Fewkes. Another sherd has a checkerboard design in parallelograms in white. One barred sherd of this type had also been made into a dice.

Black Paint-on-Red. The only red colored sherd obtained was unmarked.

No. 54a. Plate C, Fig. 1, sherds 2-4.) Three per cent red ware This village is a ruin on a sand knoll in the flat one-half mile east of ruin No. 54. It is now leveled but was evidently quite large.

Corrugated. Remarks on this ware under ruin No. 53 apply.

Black-on-White. Forty-two per cent of this ware is of the hatched type, not exactly agreeing with any figured pattern but resembling Zuni, Pueblo Bonito, and Kayenta hatched ware. Two dotted triangles occur among the designs, also a plumed lightning snake. One checkerboard design in black and white squares makes up another pattern. The other designs used are very similar to those described under ruin No. 53.

Black Paint-on-Red. Remarks on this ware under ruin No. 50 apply.

No. 56. One per cent red ware. Corrugated. The ware of this type is of crude make.

Black-on-White. A small per cent of the sherds of this type is hatched ware. Ten per cent has dotted or toothed triangles in design. The remaining designs are heavy, parallel bar work, though one sherd also has a step-design somewhat resembling the Zuni step design of Fig. 14, c, of site 71 (C. Z. R.).

Black Paint-on-Red. The sherds obtained of this type are plain red only.

No. 83. Fourteen per cent red ware. Corrugated. Sherds of this type are too few for characterization.

Black-on-White. One sherd has flag points in triangular style in design, resembling the design of Fig. 12, m, of Zuni site 146 (C. Z. R.). A part of a vase has hatched work in design. One sherd bears interlocking scrolls like the Zuni design of Fig. 14, g, of site 71

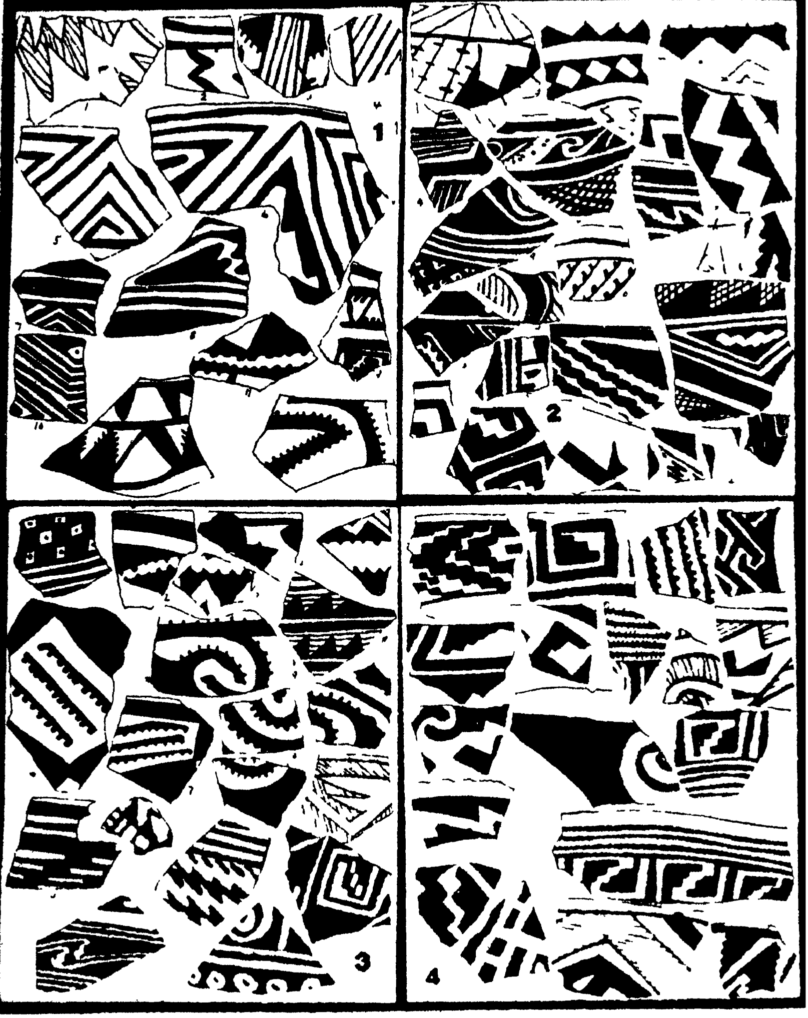

PLATE C

Fig. 1. Two-Color Painted Ware.

No. 1 is a sherd from Ruin 54; Nos. 2-4 are from Ruin 54a; No. 5 is from Ruin 82; No. 6 is a black-on-red sherd from Ruin 45N (46N); Nos. 7-10 are from Ruin 156, and Nos. 11-13 are from Ruin 162.

Fig. 2. Two-Color Painted Ware.

Nos. 1-18 are sherds from Ruin 99, at Steamboat, Arizona. No. 6 is the inside of a vessel, black-on-red, and No. 18 is the outside of the same vessel, white-on-red.

Three-Color Painted Ware Series

Nos. 19-23 are sherds from Ruin A-2. No. 19 is of the inside, black-on-red, and No. 20 is the outside of the same pot, being white-

(C. Z. R.), also a little resembling the Kayenta patterns of Fig. 60 (K. & G.). A sherd has a toothed pattern a little like the Kayenta pattern of 59, d, and two sherds have diamond figures in white with black, roundish centers like the Kayenta figure of Pl. 55, 21-28 (C. Z. R.)

Black Paint-on-Red. A double scroll design like that given above under "Black-on-White" is the main characteristic pattern of this ware. A sherd also has a pattern exactly like that on the sherd figured as Fig. 14, b, of Zuni site 82 (C. Z. R.).

Note. A land shell, found under a rock at this ruin, appears to be Oreoholix cooperi apache Pils & Ferr.

No. 99. (at Steamboat). (Plate C, Fig. 2, sherds 1-18. Six per cent red ware.

Corrugated. Almost all the sherds obtained show coarse work, reminiscent of the slab-house type. A few have narrow corrugations, both indented and plain. The lips of the jar tops in the collection are also all smooth.

Black-on-White. Fifty-nine per cent of this ware is of jars; the remainder bowls and a few dippers. One sherd if this ware is of early (slab-house) type in make and decoration, much resembling the pottery of ruin No. 2. Most of the rest is also of the early Zuni-Kayenta type. Only four sherds carry hatched patterns. One sherd bears an exact pattern to that on the vase from Sumopovi, Arizona,

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on black. No. 21 shows the outside of a vessel, the inside of which is painted plain white. The sherd of this drawing is a thin, "delicate" piece, compared with the others of the same collection. No. 22 is outside, white on very dark black or red, and No. 23 is the inside of the same vessel, same being painted black-on-red.

Fig. 3. Three-Color Painted Ware.

No. 1 is from Ruin 100; Nos. 2-5 are sherds from Ruin 158; Nos. 6-18 are from Ruin 161; and No. 19 is from Ruin 171, of the slab-house series.

Fig 4. Three-Color Painted Ware.

Nos. 1-5 are sherds from Ruin A-2. No. 1 shows the inside of a sherd whose outside is painted white; and No. 2 is a sherd whose inside is painted white. No. 6 is a sherd from Ruin A-6, and No. 7 is the inside of a sherd, black-and-white painted on "brick" color, from Ruin A-9. Nos. 8-12 are from Ruin 35. No. 10 shows the inside of a black-on-white sherd, and No. 11 the outside of a black-on-white sherd which is corrugated both above and below the design. Nos. 13-16 are sherds from Ruin 64. Nos. 13 and 14 are the inside of pots, which are painted with "chocolate color" for the darker part and a light yellowish chocolate for the lighter part. No. 15 is the inside of a vessel that is black-on-red, the red being very shiny. No. 16 is the outside of a sherd which is decorated in white-on-red, which is quite shiny. No. 17 is a black-on-red sherd, whose outside is plain red. No. 18 shows the inside of a sherd from Ruin 64M, the outside being plain white.

of Pl. 49 (Fewkes). The sherd is also the rough-finished, coarse ware, as that vase appears to be from the plate. Three sherds carry the double coil design similar to that of Fig. 11, k, of Zuni site 14, and the Kayenta double coil design of Pl. 54, j, (K. & G.). Four sherds carry interlocking scroll designs like those of Fig. 14, g, of Zuni site 71, and one sherd carries a very similar interlocking scroll, in reverse order. Two sherds carry square (diamond) figures in white with roundish, black centers, resembling those of Pl. 55, 21, 23, 24, and 29, of Kayenta (K. & G.). Eight sherds carry white squares like those on the food bowl from Chevelon, Arizona, figured as Pl. 37, b, (Fewkes). Three sherds carry zigzag lightning figures, much resembling those of Fig. 14, e, of Zuni site 71 (C. Z. R.). Another sherd carries a heavy, saw-toothed, notched design in parallel blades, and one carries a more pointed saw-toothed design. One sherd also carries a wavy, triangular pattern, somewhat like the Kayenta pattern of Fig. 59, b, (K. & G.). And so on.

Black Paint-on-Red (including the Buff Ware). The red ware is all of bowls, and the buff (yellow) ware of jars. The one characteristic design is that of a step figure, which closely resembles the step-figures in white of Figure 14, i, of Zuni site 71 (C. Z. R.).

Note. The designs on the pottery of this ruin show a coming and going of peoples, and also show Hopi influence in design. Also as indicated, some sherds and their designs indicate a very early period of settlement, while the major part of the pottery is of the middle post slab-house, Zunian type.

No. 156. (First visit.) (Plate C, Fig. 1, sherds 7-10.) This ruin is northwest of the Ganado-Indian Wells wagon road, south of a lava butte, 3 miles northeast of the latter place. No corrugated ware was obtained on this trip, but 10 per cent of the sherds obtained is red ware.

Black-on-White. Half of the sherds are bowls, one of a dipper, and the rest of jars. One sherd has a wavy, triangular design. One has a checkerboard design like that of Pl. 38, b, on a food bowl from Chevelon, Arizona, Fewkes). Two sherds carry step-figures somewhat like those of Zuni, one of the figures much resembling the zigzag figures of Pl. 42, a, on a food bowl from Four Mile Ruin, Arizona, (Fewkes). One sherd carries "bird symbols", resembling those of Fig. 36 on a vase from Homolobi, Arizona (Fewkes). The other designs obtained are not characteristic.

One sherd obtained of this ware had been made into a disk to be used as a dice in gaming.

Black Paint-on-Red. The sherds obtained of this ware are all plain red on both sides.

Note. A thin piece of red rock was found here with designs on it in white.

Note 2. This ruin is about miles west of Homolobi, almost in the Hopi country, and its de- ...tive designs seem to be more related to those of that ruin.

No. 156. (Sceond visit, the collection being more from the basal strata of the ruin than the former collection).

The pottery of this village, in this collection, resembles that of ruin No. 8 of the black-on-White series above, except that one red colored sherd was obtained and the corrugated ware is all of a make reminiscent of the slab-house type.

No. 157. (Plate A, Fig. 2, sherds 14-18, and Plate E, Fig. 3, sherds 1-5.) Four per cent red ware.

Corrugated. Only three corrugated pieces were obtained, all of which were different from any previously collected.

Black-on-White. Ten per cent of this ware has crosshatching designs. Four bear key figures on the ends of thin interlocking arms like those of Fig. 54, b, of Kayenta (K. & G.). They also resemble the key-figures on certain Casas Grandes pottery. (See Casas Grandes Pottery above, pp. 28 and 29). They also resemble the key figure of Fig. 26 on a food bowl from Chevelon, Arizona, (Fewkes), but the inclosed squares are surrounded by more parallel lines. They also somewhat resemble the key figures on vases from Homolobi, as shown on the vase of Pl. 22, b, and Pl. 32, a, (Fewkes), also resembling the key figures of Fig. 12, f, of Zuni site 24 (C. Z. R.). One sherd carries a "bird" design similar to that of Fig. 36 on a vase from Homolobi (Fewkes). One sherd carries notched triangles on suspended cords, in duplicated series. One design is very similar to the lower of the bird design of Plate 31, a, on a vase from Homolobi, Arizona, (Fewkes). One design is that of large notched, parallel crosscut saw blades, three in number. Many of the other designs are of the heavy, parallel line-band order. The other designs not previously mentioned are not determinable on account of the fragmentary condition of the sherds, but they have a resemblance to Hopi ware.

Black Paint-on-Red. The sherds of this type are too few for characterization.

Note. This ruin is just south of the Hopi country and the patterns on its pottery show strong Hopi influences.

No. 161. (Plate C, Fig. 3, sherds 6-18.) Three per cent red ware.

Corrugated. The ware of this type is similar to that of Zuni site 71 (C. Z. R., p. 312).

Black-on-White. Six sherds carry hatched patterns. One sherd has a pattern very similar to that of Fig. 14, g, of Zuni site 71. Three carry diamond (square) figures in white with roundish centers in black, like those of Kayenta, figured as Pl. 55, 20-30. Four carry "under-framework" designs like that of Fig. 13, b, of Zuni sites 86 and 96, and those of the Kayenta designs of Fig. 53 and Fig. 54, a, (K. & G.). Five sherds carry zigzag, step lightning-snake figures, similar to those of Fig. 13, j, of Zuni site 146, and Fig. 14, h, of Zuni site 71. They also resemble the Kayenta designs of Pl. 55, 13, 14, 19, and 23. One sherd has a zigzag figure in duplicate like the zigzag figure of Fig. 15, b, of Zuni site 149 (C. Z. R.). One sherd has a double spiral figure like that of Fig. 11, k, of Zuni site 14, and an-

other, which appears to be a similar figure, has its spirals dotted on the outer side. Three sherds carry small squares in white very much like those of Pl. 61 on (upper) food bowl from Four Mile Ruin (Fewkes), but more like the pattern of Fig. 14, j, of Zuni site 71, (C. Z. R.), and so on.

Black Paint-on-Red and Black and White Paint-on-Red. The sherds of these types are too few for characterization.

Note. The sherds would place this ruin in age with that of Zuni sites 71 and 149. They also indicate a more than usual overlapping of Kayenta culture in this region.

This ruin properly belongs to the next series of ruins to be considered.

No. 162. (Plate C, Fig. 1, sherds 11-13.). Two per cent red ware.

The pottery of this ruin is very similar to that of ruin No. 161 except there is no three-colored red ware.

THREE COLORED PAINTED WARE SERIES.

The ware of this series is the same as that of the Two Color Painted Ware Series above, with the addition of the Three Color Painted Ware. The ware, however, shows an advance in composition and decoration over that of the former. The percentage of red and buff ware will be given following the village number as previously.

No. A 2. (Plate C, Fig. 2, sherds 19-23 and Fig. 4, sherds 1-5.) Twelve per cent red ware.

Corrugated. All of the 35 pieces obtained were of large pots. One piece was deeply grooved and another was poorly made, the corrugations being irregular and flattish. Six sherds are parts of tops of jars and show no corrugations. One sherd is well made and seems to be of a later type than the rest of the specimens. All the rest of the sherds are almost smooth, but show crude corrugations. On the whole the ware of this class approaches that of the slab-house type.

Black-on-White (and Black Paint-on-White). This ruin had no shiny painted ware, although on some pieces the paint is more shiny than on others. The black paint is also sometimes of a browish or purplish brown tinge.

Fifty pieces of this ware were obtained. Two of these were smooth bottoms of large jars, and one is a handle of a jar. The bowls and jars represented are as 14 to 36, there being more than twice as many jars as bowls. The patterns are mostly of the broad, heavy line type. Some hatched work occurs but it is small in amount. Three sherds have opposed sets of isosceles triangles with their points touching, thus leaving diamond-shaped interspaces, the center of each one of which is occupied by a dot like the Kayenta ware of Pl. 55, 21-29 (K. & G.). Four pieces have designs which approach the Kayenta sherd-design of Pl. 54, j, (K. & G.) and that of Fig. 11, k, of Zuni site 14 (C. Z. R.). One design much resembles that on the Zuni pot of Fig. 14, b, of site 71 (C. Z. R.). Seven sherds have designs very similar to those of Fig. 14, g. c, and d of Zuni site 71 and of Fig. 15, a, b, c, of Zuni site 149 (C. Z. R.). One fragment

has a series of almost Z-shaped designs, a design which is often seen in this section. A pattern on another sherd is like that on sherd figured as Fig. 14, i, of site 71 above. Another sherd has very similar pattern, and the inside pattern on a sherd of a bowl also favors it in shape. One sherd has a single lightning pattern like the double lightning design of Pl. 39, b, on a sherd from Chevelon, Arizona, (Fewkes). Another design is entirely different from any previously seen. It is a series of bands with projecting knobs, probably representing cloud bands with suspended rain-drops.

Black Paint-on-Red. All the sherds found of this type are of bowls. It should be added that three-eighths of the sherds are painted in an under color of buff-red instead of pure red.

Black and White Paint-on-Red. No jars of this type were found. The white paint, as in most cases where it is used on red, is a smear, though intended to be put on in regular lines. It is also nearly effaced from many of the sherds, having been worn off by use and weathering.

The inside design on one sherd is very similar to that on Fig. 15, b, and e, of Zuni site 149 (C. Z. R.). The other designs are not conspicuous enough to be noted here, though one resembles that of Fig. 11, k, of Zuni site 14, (C. Z. R.).

No. A-6. (Plate C, Fig. 4, sherd 6.) Five per cent red ware.

Corrugated. The sherds of this type are all of large mouthed, large jars and pots. The tops of the jars obtained, three in number, are not corrugated. One-eighth of the sherds have had the corrugations rubbed off. Two sherds have just plain corrugations. One-fifth of the sherds show very coarse indentation work. In fact, all of the above sherds show work reminiscent of the slab-house type of pottery. The remaining sherds show characteristic narrow, indented coils.

Black-on-White. Fifty per cent of the sherds are parts of jars, one dipper is represented by a handle, and the remainder are fragments of bowls.

Two sherds show checkerboard design work. One design resembles that of Fig. 13, n, of Zuni site 146 (C. Z. R.). Another design resembles that of the Zuni sherd figured as Fig. 11, k, of site 14 there, and is practically identical with the Kayenta design, shown as Pl. 54, j, (K. & G.). One sherd shows some hatched work. Practically all the other sherds have broad, parallel line designs.

Rough-Dull-Gray Ware, Without Slip. Five pieces of this ware were obtained, one having been made into a gaming disk.

Black and White Paint-on-Red. No red colored sherds were obtained, except of this type, and none of these were of the shiny painted class. The white paint, as usual, was the smeared-on type, being only on the outside. One design is like that of Fig. 14, i, of Zuni site 71. The others were not different from those previously described.

All the sherds obtained of this type are of bowls.

No. A 9. (Plate C, Fig. 4, sherd 7). Six per cent red ware.

The pottery at this ruin was scanty. Only eighteen pieces were obtained. No shiny painted ware and only one red piece (of a bowl) that had been daubed with a white band, was found about the site.

Corrugated. Seven-ninths of the sherds of this type had had the corrugations rubbed off, and the remainder had well made, narrow indented coils.

Black-on-White. Two sherds of this ware have patterns very similar to the step pattern of Fig. 15, i, of Zuni site 149 (C. Z. R.), and the very similar pattern on the sherd shown as Fig. 14, d, of Zuni site 71, of the same series.

Rough-Dull-Gray Ware, Without Slip. Six gray pieces and one black sherd of this type were obtained at this ruin.

Black Paint-on-Red. Only three red pieces of bowls were obtained, one of which was red on both sides. One of the other sherds had a step figure very much like that of the Zuni sherd shown as Fig. 13, l, of site 146. One sherd shows hatched work. Another has the double spiral design like that of Fig. 11, k, of Zuni site 14 (C. Z. R.), and the Kayenta design Pl. 54, j, of Kidder and Guernsey, in combination with a vertical saw-toothed series of vertical lines, and still more like the saw-toothed figures, shown on figure No. 23 of Pl. 55 (K. & G.), and the saw-toothed design shown on the neck of the Kayenta dipper as Fig. c of Pl. 15 (Fewkes, Bull. 50). Most of the remaining designs are of the heavy type, mostly of the broad line series.

Note. The pottery designs of this ruin are about half and half Zuni and Kayenta patterns. The corrugated ware and the most characteristic designs, however, are similar to those of Zuni site 71 (Fig. 11, and pages 222 and 306, C. Z. R.).

No. 35. (Plate C, Fig. 4, sherds 8-12.) Three per cent buff ware was obtained, but no red ware was found about the site.

The pottery of this ruin is very similar to that of ruin No. 34 of the black-on-white series above with some additional designs and the additional per cent of buff ware mentioned above. One sherd has the double coil design of both the Kayenta and Zuni series. One partly corrugated sherd has designs in black and white on both sides. Another seems to have been the drawing of some beast.

No. 264. This is the ruin opposite the sheep dip, east of Pueblo Colorado Wash at Ganado. For pottery analysis, the lower part of this ruin between the cross-wash south of the main village and Hubbell's store is designated as 64 L, and the main village as 64 M, as given below.

No. 64 L. (Plate C, Fig. 4, sherds 13-17.) Six per cent red ware and 13 per cent buff ware, totaling 19 per cent.

The corrugated ware of this part of the ruin is on the whole of the well made, narrow, indented type, though crude work appears on many sherds, reminiscent of the slab-house type. The black-on-white ware carries no new designs except one that looks like an old fashioned barbed wire, with the barbs extending across the wire.

Seventy per cent of the red series is of buff-yellow ware, which indicates a late type. Black and dull ware of the gray type without slip, twenty-five per cent of the sherds found, thirty-five per cent of which is black ware, also occur at this site, apparently also of the late type. The coming in of so much black ware of this type and the introduction of the buff yellow ware with such a large per cent, is an innovation worthy of notice.

No. 64 M. (Plate C, Fig. 4, sherd 18.) Forty-eight per cent of red and buff ware combined; red ware twenty-five per cent.

Corrugated. Remarks under ruin No. 64 L apply to the ware of this site, as well.

Black (Rough-Dull-Gray Ware, Without Slip. Only two sherds referable to this type were obtained.

Black-on-White. One sherd carried a design resembling the step designs of Fig. 14, c, and d, of Zuni site 71 (C. Z. R.).

Black Paint-on-Red. Sixty-two per cent of the ware thus classed is light red to yellow-buff ware. Two sherds also carry a red step design on brown-buff. Three of the buff sherds carry step designs resembling those of figure 14 c, and d, and those of Fig. 15, b, e, and i, of Zuni site 149 (C. Z. R.). They also resemble the design on the upper part of the Pueblo Bonito pitcher figured on Pl. 7 (Pueblo Bonito). Pottery with somewhat similar designs has also been found elsewhere in the southwest, but does not come so near being the same. pattern. Some of these step designs are figured by Fewkes as part-decoration patterns as follows: Pl. 69, c, on food bowl from Pueblo Viejo, Pl. 50, b, on a vase from Shumopovi, Pl. 38, b, on a vase from Chevelon, Pl. 22, b, on a vase from Homolobi, etc

Black and White Paint-on-Red. The only characteristic designs found with this type of pottery are a step figure, very similar to the last above, and a cross, checkerboard, fence design on the reverse side of the same sherd.

Note. The writer is disappointed in the pottery from this (the whole) ruin. There is too little of it in comparison with the size of the ruin, probably due to the fact that tourists and investigators have been collecting pottery from it since its discovery in 1857. Moreover, as there are traditions concerning the site (see the writer's previous report*, he was in hopes that the pottery findings would

*See Wukopakabi, the Hopi name for this pueblo, locally known as Pueblo Ganado and Pueblo Colorado. Handbook of American Indians, Part 2, p. 976.

give some clue to the migrations of its inhabitants as set forth in the traditions. In a way, too, they do, as there are sherds with Inscription Rock designs and, again, there are sherds with designs resembling ancient Hopi ware. The introduction of so much buff ware also shows that there was an incoming of a foreign people of a transient nature, as buff or light buff-yellow pottery does not form a conspicuous part of the pottery of any other ruin so far examined in the region, except that of Kinna Zinde.

No. 100. (At Steamboat.) (First visit.) (Plate C, Fig. 3, sherd 1.) One per cent red ware.

Corrugated. The ware obtained is of crude type, but the sherds are too few for any definite statement.

Rough-Dull-Gray Ware, Without Slip. Only one sherd of this type was obtained.

Black-on-White. Twenty per cent of the sherds of this type are hatched in design. One sherd bears a checkerboard design of white squares. The other sherds are painted in heavy line and band work, usually of the parallel order.

Black and White Paint-on-Red. The sherds of this type are too few for characterization.

No. 100. (Second visit.) (Plate C, Fig. 3, sherd 1.) Three per cent red ware. This visit gave an almost identical percentage of sherds of the black-on-white ware. There were also sherds with squares (diamonds) in white with black central centers, like those of Kayenta of Pl. 55, 21-29 (K. & G.). Of the red ware one sherd also carries the characteristic Zuni step design.

No. 158. (Plate C, Fig. 3, sherds 2-5.) Five per cent red ware; buff ware 2 per cent.

Corrugated. This ware is of the narrow corrugated, usually well made type, considering it as a whole, though quite a per cent of it is un-indented ware.

Black-on-White. Thirty-six per cent of the ware of this type is hatched in decoration. Six sherds carry key figures and adjoining, dotted triangles, like that of Fig. 12, f, of Zuni site 24 (C. Z. R.). The other determinable designs are very similar to those previously described under ruin No. 157.

Black Paint-on-Red. This includes one sherd of red and brownish-black on buff and three reddish (buff) patterns on white. The other designs are of the red and black parallel bar type.

Note. This ruin is on the edge of the Hopi country and its patterns show Hopi influence.

No. Ga. This is an analysis of an accumulation of sherds that were picked up here and there in the vicinity of Cornfields without reference to any particular site. The sherds were as follows: 54 corrugated (22 of a make reminiscent of the slab-house type, and 23 were fairly well made, being narrow, mostly indented coils—3 sherds of the latter are of the black type and one has a black-on-white figure on the inside; 23 red including one buff sherd (7 of these are three-colored-black and white paint-on-red, and 15 black-on-red ware), and 239 black-on-white ware (19 of the slab-house type, 26 hatched sherds, 4 gaming disks, one barbed wire figured sherd and 189 other sherds of the black on white type). Only the black-on-white type will receive further notice.

Black-on-White. Eight per cent of this ware is of the slab-house type, a large per cent of which has patterns like those of Fig. 11, f, and g, of Zuni sites 14 and 40 (C. Z. R.). About 11 per cent of the ware is of the hatched type, much of it resembling Pueblo Bonito hatched ware, one of these sherds also carrying a pattern that much resembles that of Pl. 55, 3, of Kayenta (K. & G.). One sherd carries

a key, zigzag, step figure like those of the Casas Grandes patterns above cited. Three sherds carry Kayenta diamond designs in white with blackish-roundish centers. Several sherds also carry squares and elongated figures in white, very similar to that of Pl. 61, on a food bowl from Four Mile Ruin and those on Pl. 39, b, and Pl. 37, b, on food bowls from Chevelon, Arizona, and one carries an exact pattern to that of Fig. 83 on a cup from Kintiel (Fewkes). One sherd carries an elaborate M in black. One sherd carries tasseled triangles in black. Several sherds carry dotted and saw-toothed, notched triangles and notched saw blades, one double notched blade resembling a double-notched buck-saw blade. One sherd carries noded parallel lines. One sherd carries a pattern that somewhat resembles that of Fig. 13, k, of Zuni site 146, and two carry step patterns that also somewhat resemble the Zuni step patterns of sites 146, 149 and 71 (C. Z .R.). Three sherds carry spiral patterns like those of Fig. 11, i, and j, of Zuni site 14 and 40. A dipper handle carries a double spiral, and a sherd carries an interlocking, double spiral pattern, the double spiral in each case being like that of Fig. 11, k, of Zuni site 14, and the Kayenta double spiral design of Pl. 54, j, (K. & G) One sherd carries a design in white which much resembles the Kayenta pattern of Pl. 16, b, of Fewkes. And so on.

No. Gb. The writer had the school children collect sherds for their drawing work. These were collected in their going to and coming from school, and represented, fairly well, the pottery of the small-house ruins in a radius of two miles of the school. As the sherds were collected by the children themselves, the exact site from which any sherd was obtained was not ascertained. The children also collected no corrugated nor rough-dull-gray, undecorated ware.

The sherds are 16 (2 per cent) black paint-on-red ware (including one buffish red sherd), and 852 (98 per cent) black-on-white sherds (including the shiny painted ware). The black-on-white ware will be further considered.

Black-on-White. Of this ware 135 sherds (or 16 per cent of the black-on-white ware) is of the hatched type; 63 sherds are of the slab-house make of pottery both in paste and pattern, and 18 of these carry patterns like that of Fig. 11, j, of Zuni site 40. Four others carry the pattern of Fig. 11, g, of Zuni site 14 (C. Z. R.), and thirteen carry the Z-N design of Pl. 63 of the Kayenta slab-house type of pottery (K. & G.), only the figures of the Cornfields pottery are made better. Twenty-two sherds (2 1-2 per cent of the whole) bear Zuni step figures like those figured from Zuni sites 71 and 149 (Fig. 14 and 15). Sixty-five, (8 per cent) carry designs of dotted and notched trianges, and saw-toothed, notched saw-blades, including seven key figures and three designs in white like those on the body of the vase figured as Pl. 16, b, from Kayenta (Fewkes), except that the Cornfield's pattern contains three notched horizontal bars instead of two. Six sherds carry interlocking scroll designs just like or closely resembling those of the pattern of Fig. 14, g, of Zuni site 71 (C. Z. R.). Six sherds have been shaped into gaming disks. Four

sherds contain flag-like triangles, resembling those of the Zuni pattern of Fig. 12, m, of Zuni site 64. Four carry diamond (square) designs with roundish, black centers, like those of Pl. 55, 21-30 (K. & G.). Thirteen carry zigzag lightning figures like the Kayenta pattern of Pl. 55, 13, 14, 15, 19, 20, and 23, and patterns of Fig. 13, j, and m, of Zuni site. 146. Twenty sherds carry double spiral patterns either exactly like or closely resembling that of Fig. 11, k, of Zuni site 14 (C. Z. R.), and the Kayenta, double spiral design (hooked pattern) of Fig. 56, b, c, and d (K. & G.). And so on.

Note. Nos. Ga and Gb both contain some shiny painted ware, but have been included in this (Three Color Painted Ware) resies because their sherds belong more, on the whole, to it than to the Shiny Painted Ware Series following.

SHINY PAINTED WARE SERIES*

The pottery of this series is much the same in make and design as that of the last series, with the addition of the shiny painted ware. There is, however, an improvement in technique and decoration. It should also be added here that some near glazed ware and one glazed sherd occur in the collection.

*The writer sent some sherds of shiny painted ware to the American Museum of Natural History, and the Curator of Ethnology there, Pliny E Goddard, wrote him in reply concerning them· "The sherds you sent are clearly painted ware 'black-on-white' ". They, however, have quite a different appearance from the ordinary black-on-white ware.

No. A. (Plate D, Fig. 3, sherds 1-25 and Plate E, Fig. 2, sherds 1-23.) Twenty-three per cent red ware.

In discussing the pottery of this ruin, the writer wishes to state that its ash heaps are very small in comparison with a village of its size, the largest village in the Cornfields region, probably having housed from 500 to 600 people. This would seem to indicate that it was not inhabited long. The writer wishes also to add that last year before he began this comparison, a large quantity of sherds were collected from the surface of this ruin and sent to the Kansas Academy of Science. Various other people have also collected sherds from it. Therefore, since the writer did no excavating, the findings are subject to revision, even for surface potsherds.

Corrugated. This ware is varied, a conglomeration in fact. Five sherds are like those of Pl. 57, h-p (K. & G.) of Kayenta. Several other sherds are poorly made ware like that of 57, d, and other Kayenta slab-house types, given as Pl. 64, e, by Kidder and Guernsey. In some cases the coil has been almost completely removed. Some jars also had plain bodies and plain "lips" and the corrugations of the necks were straightridges much resembling the slab-house type. On the whole, however, the indented coil prevails. One sherd is also painted in black on a smooth white background on the inside, reminding one much of Pueblo Bonito corrugated, painted ware.

On the whole the jars are light and of medium size, are globular, and in their make up, seem to indicate that they were made by a

heterogeneous group of people who had been hurriedly collected in the village, suggestively for protection from enemies.

Black-on-White. Five sherds have interlocking scroll patterns similar to that of Pl. 53, j, (K. & G.), similar in coil, but different in trimmings. These scrolls also resemble the scroll patterns of Fig. 11 k, (C. Z. R.) and Fig. 56, d, (K. & G.). One step-like, zigzag, key figure on the ends of interlocking arms of interlocking figures is exactly like that of Fig. 13, l, of Zuni ruin 148 (C. Z. R.). Twenty-three other very similar patterns also somewhat resemble those of Fig. 13, l, and n; Fig. 16, c, and d; Fig. 15, h, e, and i, of the same publication, and the pattern on a food bowl from Pueblo Viejo from the upper Gila valley, given as Pl. 69, c, (Fewkes), also like step-like designs on upper pitcher from room 8 in Pueblo Bonita of Pl. 7 (Pueblo Bonito). Five interlocking scrolls were also found similar to that of Fig. 11, k, (C. Z. R.). Fifteen patterns are of various checkerboard types, several being of the "under framework" type. Several of the other fragments are decorated with a series of triangles. Six of the sherds are decorated with opposed sets of isosceles triangles with points interlocking, thus leaving diamond-shaped interspaces, each of which is occupied by a single dot, one exactly like and the others much resembling the designs of certain Kayenta ware (see Pl. 55, 21, 22, 23, 24, 27, and 28, of K. & G.). Quite a per cent of the designs are of the "heavy" type. Forty-seven of the sherds show hatched designs. Several figures on sherds also closely resemble that of Fig. 14, i, (C. Z. R.), of Zuni site 71, one being identical. Several other figures are identical with or similar to that of Fig. 14, b, of Zuni sites 81 and 82 (C. Z. R.).

Two Color Shiny Painted Ware. About three-fourths of the sherds of this type are parts of jars. A few of the remaining sherds are parts of dippers, and the others, bowls. Some of the bowls show the style of design of the sherd figured as Fig. 13, k, and the dippers (and also some of the bowls) show the interlocking key figures of Fig. 13, l and n, of Zuni site 146 (C. Z. R.). There is also a close similarity of these patterns to those of Fig. 14, c, and f, of Zuni site 71. The jars, as in the case of Zuni ruin 146, also often show bold curvilinear forms, using alternations of broad line and hachure figures. There is also close resemblance between the designs on the sherds of this ruin and those of Zuni site 149, ecpecially those of the step, key figures of Fig. 15, a, b, e, and i, figured from that ruin. One sherd also has an "under framework" pattern similar to that of Fig. 54, a, of Kayenta (K. & G.).

Black Paint-on-Red. All the sherds obtained are of bowls. Several fragments have a design similar to that of Fig. 14, i, (C. Z. R.). The other designs are very similar to those previously described.

Black and White Paint-on-Red (including three per cent of buff ware and some three-color shiny painted ware). Only bowls are represented, not a single jar sherd being obtained. These bowls usually are decorated in black over red on the inside and in white (rarely in black and white) over red on the outside. The white is often more

smeared over the surface than painted, as though it had been put (or daubed) on after the pot had been burned once and it had not well set. The putting on, too, does not show the neatness of the other painting, as though it might have been done by some amateur. It also has the appearance of the white painting becoming a "fad" and the white paint was daubed on jars in use. Some of the white de-

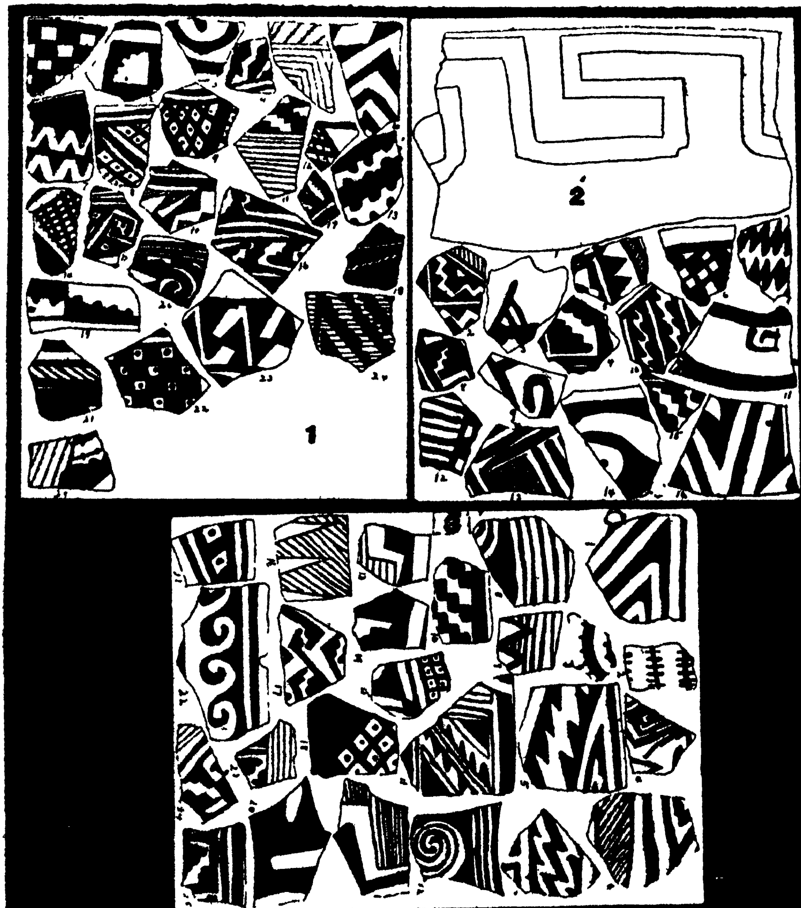

PLATE D

Fig. 1. Shiny-Painted Ware Series

Nos. 1-6 are sherds from Ruin 45. Nos. 7-13 are from Ruin 94. Nos. 14-18 are from Ruin 169 (Klagitoh). No. 14 shows the inside of a sherd that is black-on-red on that side, and No. 15 shows the inside of another sherd that is similarly colored on that side, both sherds being plain red on the outside. Nos. 19-20 are sherds from Kintiel.

signs, however, show careful work, as does the other designs on the same sherds. The interior decorations are usually panels extending over the whole surface. The intervening areas are rather closely filled with broad lines and hatched figures, generally of the interlocking, often of the heavy type. The exterior decoration is open and "heavy", consisting of broad "heavy" lines, rectangular panels, and angular meanders, which extend only about half way down the side, but encircle the bowl. Also less commonly, the interior is covered with white paint, bearing the design in black, and with the exterior a plain red. Before me there is a sherd also wholly gray on the inside and the outside is covered with white paint, bearing the designs in red. Another sherd has the outside wholly black and the inside covered with red paint, bearing the designs in brownish-black. Still another has a rough, unpolished, unpainted gray interior, and the outside covered with a dull red paint, bearing the designs in black.

Note. A human bone was found near the east end of this ruin. A land shell, succinea avara Say, was also found under a rock at this village.

A Concluding Remark. Though some of the corrugated ware seems to be of the slab-house type and one decorated sherd is of the Pueblo Bonito age, the shiny painted ware and the per cent of corrugated ware seem to indicate an age for this village corresponding to that of Zuni sites 71 and 146 (C. Z. R.), according to Spier's analysis, and possibly site Shoptlawwatla according to Kroeber's findings.

No. A E. (Plate E, Fig. 1, sherds 1-4). Twelve per cent red ware. These sherds were obtained in the village debris east of the main village of ruin No. A, and apparently represent a more ancient village

Nos. 21-25 are sherds from Kinna Zinde. No. 23 represents the outside of a sherd which is black-on-red on that side and unpainted on the reverse side. No. 24 shows the inside of a sherd which is black-on-orange-red on that side, the outside being painted orange-red (buff).

Fig. 2. Shiny-Painted Ware Series

No. 1 is the outside of No. 6 in Fig. 1, Plate E, from Ruin AK, the design being painted white-on-red. Nos. 2 and 3 are sherds from Ruin AK4. No. 4 the inside of a sherd that is black-on-red on that side, the reverse side being plain red. Nos. 4-7 are sherds from Ruin the AK5. Nos. 8-11 are from Ruin A-3. No. 12 is the inside of a sherd from Ruin A-4, a sherd that is corrugated on the outside. Nos. 13-16 are from Ruin 45.

Fig. 3. Shiny-Painted Ware from Ruin "A" (Unitsosie Bogan), Etc.

Nos. 1-25 are sherds from Ruin "A". No. 13 shows the inside of a sherd that is black-on-red on that side, and No. 14 is the reverse side of the same sherd, which is white-on-red on that side. No. 19 represents the inside of a sherd that is black-on-chocolate on that side, and No. 20 the outside of the same sherd, which is white-on-red on that side.

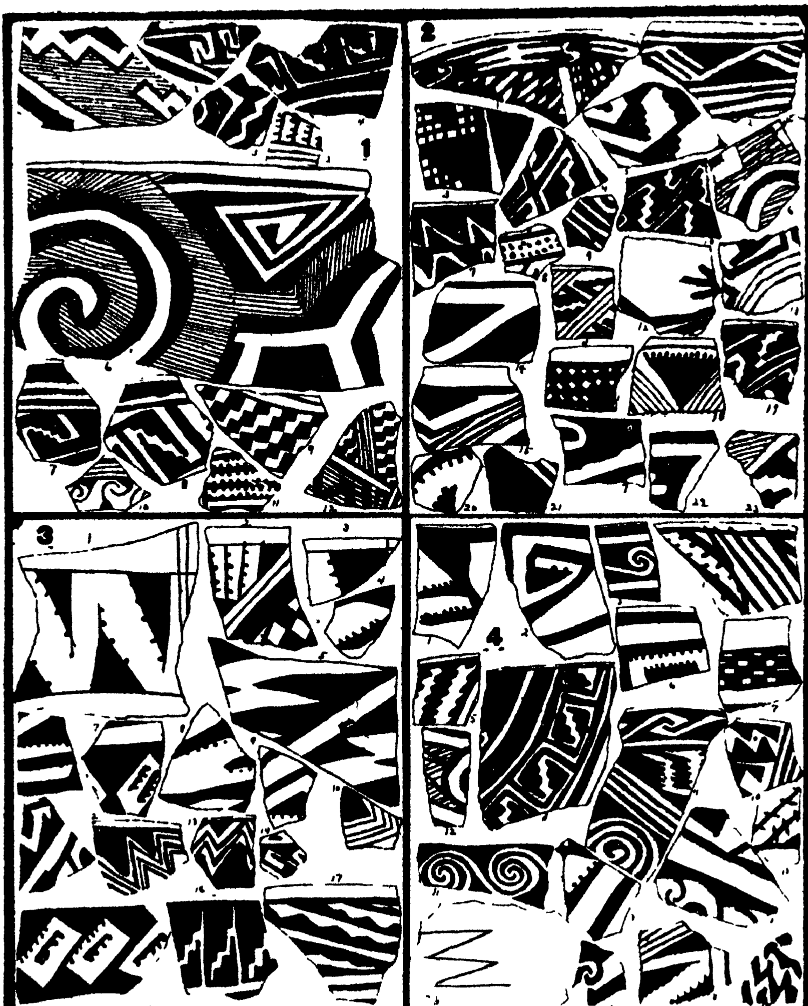

PLATE E

Fig. 1: Shiny-Painted Ware Series.

Nos. 1-4 are sherds from Ruin AE. No. 3 shows the inside of a sherd which is shiny brown-on-black on that side and red on the reverse. Nos. 5-8 are sherds from Ruin AK. No. 6 shows the inside of a sherd which is plain red and white and black-on-red, on that side, and No. 1, Fig. 2, Plate D, shows the reverse side of the same sherd, which is white-on-red on that side. No. 7 is the inside of a sherd, which is black-on-red on that side and white-on-red on the opposite side, as in drawing No. 8. No. 9 is a sherd from Ruin AK2. Nos. 10-12 are from Ruin AK4.

than that of A, judging from its appearance. The pottery also bears out that conclusion, at least in part, as the corrugated ware aggregates 40 per cent of the sherds obtained.

Corrugated. So far as can be learned from the fragments, they are all of jars, with non-corrugated, straight, wide necks. Thirty per cent of the 57 pieces obtained of this ware is a slab-house pottery. Most of the coils are partly or wholly obliterated, while the others are of coarse make, usually of wide, flattish corrugations. The remaining sherds bear narrow corrugations, both indented and plain, one of them having both indented and plain coils. One sherd is also perforated with small holes, having evidently been used as a ceremonial sprinkling bowl. Plain vessels without coils are also reppresented by sherds, and will be mentioned under rough-dull-gray ware without slips, next below.

Rough-Dull-Gray Ware, Without Slips. The sherds of this type are all of jars. They are undecorated, dull of color and nearly all lack a slip. They are gray of color and usually rough and of rough make.

Black-on-White (including Shiny Painted Ware). Five per cent

Fig. 2: Shiny-Painted Ware Series

Sherds 1-23 are from Ruin "A" (Unitsosie Bogan). Nos. 5 and 6 show the inside of a vessel which was black-on-red on that side and plain brown on the other. No. 8 shows the inside of a sherd that is brown-on-light-tan on that side and light tan on the other. No. 14 shows the outside of a sherd that is white-on-brown on that side, and No. 15 is the reverse side of the same sherd which is black-on-brown on that side. No. 16 shows the inside of a sherd which is black-on-red on this side, and No. 17 is the outside of the same sherd which is white-on-red on that side. No. 18 is a sherd that is brown-on-white on that side and plain white on the inside. No. 20 the inside of a sherd which is black-on-red on that side, and No. 21 is the outside of the same sherd which is black and white-on-red on that side; the longer white stripe is black and the other one is white on the sherd. No. 22 is the outside of a sherd that is white-on-brown on that side, and No. 23 is the inside of the same sherd which is black-on-red on that side.

Fig. 3: Unclassified Potsherds

Nos. 1-5 are sherds from Ruin 157; 6-14 are from Ruin 167N-2 and are of slab-house type of pottery; and Nos. 15-17 are sherds marked "GA", designating a general assortment. Nos. 15 and 16 are the outside of tops of jars and No. 17 is the inside of a top of a jar.

Fig. 4: Unclassified Sherds from the General Assortment ("GA").

Nos. 1 and 7 are the outside of the tops of jars; Nos. 2-6 are the inside of sherds that are tops of jars, and Nos. 8-11 are fragments of tops of jors. Nos. 8, 9 and 10 are the insides of sherds, and No. 11 is the outside of one.

of this ware is of the shiny painted series. About two-thirds of the total sherds of this type are parts of jars, one dipper being also represented. One sherd has a pattern exactly like that of Fig. 14, g, of Zuni site 71 (C. Z. R.). Another sherd has a pattern like that of "c" of the same figure. Six others also have similar designs, which also somewhat resemble the step figures of Fig. 15, b, e, and i, of Zuni site 149 (C. Z. R.). Two sherds have a design much like that of Fig. 14, i, of Zuni site 71 (above). Another has the double spiral design, much like that of Fig. 11, k, of Zuni site 14 (C. Z. R.), and that of the Kayenta sherd, figured as Pl. 54, j, (K. & G.). Another design looks much like the spread wings of a moth. White "square-oblongs" appear on one sherd, resembling similar markings on the Kayenta jar given as Pl. 53, b, (K. & G.). Another sherd carries a design very similar to that of the Kayenta sherd, figured as Fig. 56, f, (K. & G.). Hatched work also occurs on several sherds, as does "heavy" line work. A sherd also bears a saw-toothed design very similar to the Kayenta designs given as Fig. 55 and Pl. 55, 13, 14, 15, 16, and 23, more especially like those of the latter pattern. It also resembles the similar Zuni patterns figured on the sherd, given as Fig. 14, b, of Zuni site 71 (C. Z. R.).

Black-Paint-on-Red. This includes one sherd whose design is red on white. The designs of the ware of this type are similar to those described under ruin No. A. One sherd also has a design very similar to the Zuni step designs of Fig. 14, c, and d, of site 71 above. Another sherd shows a near glaze in black on the outside.

Black and White Paint-on-Red (including a sherd that has black paint on red on the inside and black paint on white in broad lines on the outside). The designs here and their manner of being painted are very similar to that described under ruin No. A above, and that which will be described later.

No. A. K. (Plate E, Fig. 1, sherds 5-8; and Plate D, Fig. 2, sherd 1.) Twenty-six per cent red ware. This is a small-house ruin 40 paces west of the ruin No. A. It was previously reported under the caption ruin No. A. Including its refuse heap, it is D-shaped. Below is an analysis of its pottery.

Corrugated. Fifty per cent of the sherds had the coils more or less obliterated, some being reindicated by incised lines, resembling Kidder and Guernsey's slab-house corrugated ware of Pl. 57, d, and Pl. 64, e. The other corrugated ware is well made, with characteristically narrow, usually indented coils.

Black-on-White (including the Shiny Painted Ware). More than one-half of the vessels are of bowls. Three dippers and parts of five ladles are represented. The rest are parts of jars.

The painting is brownish black with the exception of the design on one sherd which is a greenish black. On the whole the designs are very similar to those described under ruin No. A. Two double spiral figures, much resembling those of Fig. 11, i, and k, of Zuni site 14 (C. Z. R.), and Pl. 54, j, (K. & G.), are among the designs represented. Hatched designs are common, though not the prominent designs, be-

sides the work is coarse lined. Three checkerboard designs in white, one outside and one inside, much resemble the designs on a food bowl from Chevelon, Arizona, (Fewkes, Pl. 37, b.). One sherd has a saw-toothed design somewhat similar to those of Pl. 55, 13, 14, 15, 16, 20 and 23 (K. & G.), and especially like those of Fig. 13 above, though it differs from it in some particulars. It also somewhat resembles the design on Fig. 13, j, of Zuni site 146 (C. Z. R.). A very common design is the step figure, which much resembles those of Figs. 14, c, and d, of Zuni site 71, and 15, b, e, and i, of Zuni site 149 (C. Z. R.), and a design, painted in white on black, much resembles that of Fig. 15, l, also of site 149 above.

Black Paint-on-Red. Ten per cent of the ware of the village is of this type and of plain red on both sides. The designs are similar to those noted under ruin No. A for this style of ware.

Black and White Paint-on-Red. All the sherds found of this type are of bowls. Two of the patterns obtained are very similar to those of Fig. 14, c, and d, of Zuni site 71 (C. Z. R.), one being practically identical with that of 14, c, and the other practically identical with the inside drawing of Fig. 15, b, of site 149. Others closely resemble the designs of Fig. 15, e, and i, from the same Zuni site. The white in these cases, as with this type of pottery of ruin No. A, is smeared over the red, apparently after the latter paint had been fired. It also shows crudeness in the painting. No hatched work shows in the red ware, except that of the sherd next described. This sherd is a fragment of a very large bowl. It is painted in black, white, and red, on the inside, and white over red on the outside. No exact pattern to any of the designs on it are shown in the cuts before me, but in a way it resembles the patterns of Pl. 54, j, (K. & G.) and the double spiral coil of Fig. 11, k, (C. Z. R.). Its large interlocking volute also resembles designs on some of the pottery near Pagosa Springs, Colorado. It is also somewhat like the large (spiral design) curl-coils of Pl. 25, b, Pl. 40, a, Pl. 64, and Pl. 47, b, of Fewkes. This fragment, which is one-fourth of the bowl, also so resembles the Four Mile Ruin spiral coil ware that one would, in fact, almost believe it had been gotten from that pueblo by the latter. There is one feature, however, that is not of Hopi ware, though Dr. Fewkes was of the opinion that Four Mile pueblo was a Hopi village. This bowl fragment is decorated in black and white over red, and the red is a slip, rubbed over coarser clay. In firing, since the contraction and expansion of the slip is not the same as that of the base on which it is laid, it has a crackled surface, unknown to Hopi ware, but very common with the black and white ware of Kintiel, which Dr. Fewkes has considered a Zuni ruin.

No. A K 2. (Plate E, Fig. 1, sherd 9.) Nineteen per cent red ware. This is a small-house ruin about 100 yards northwest of the northwest corner of ruin No. A. It was included in the description of that ruin in my former report. The analysis of its pottery is as follows:

Corrugated. Only 20 per cent of it would be considered well made.

The rest is more or less crude, the indentations being entirely removed from one large piece of a large jar. In many respects this ware resembles Kidder and Guernsey's slab-house corrugated ware.. It should be added that one of the well made pieces is of a pot or dipper with a handle.

Black-on-White (including the Shiny Painted Ware). Forty per cent of this ware is of food bowls; four dippers are represented by the handles, and the remainder are of the jar type. Only a small per cent of the sherds show hatched work in design, and all of this is of the broad line variety. Two checkerboard designs were obtained, but resemble no designs from other regions. One sherd has a saw-toothed design. Three sherds have designs like those of Pl. 54, j, (K. & G.) and Fig. 11, k, of Zuni site 14 (C. Z. R.). There are also step figures, resembling those of Fig. 14, c, and d, of Zuni site 71, and Fig. 15, b, e, and i, of Zuni site 149 (C. Z. R.).

Black Paint-on-Red. All sherds obtained of this type are of bowls. No characteristic designs were obtained.

Black and White-on-Red. The sherds of this ware are all of bowls. Their patterns do not differ from those of ruin No. A proper.

Shiny Painted Ware (other than that previously mentioned). One of the sherds obtained needs special mention. It is of a bowl. It is painted in black shiny paint on a reddish metallic gray on the inside and white and red on the outside, which is without the shiny luster. The design on the inside is also that of a step figure very similar to that of Fig. 15, b, of Zuni site 149 (C. Z. R.).

No. A K 3. Twenty-four per cent redware. This is a small-house ruin 70 yards north of the middle of ruin No. A. Its pottery gave the following:

Corrugated. Forty-one per cent of this ware is of poor grade, being crudely made. The remainder bears narrow, indented coils, except fom the plain rim section.

Black-on-White (including the Shiny Painted Ware). Twenty-six per cent of the sherds of this ware are of bowls; one dipper is represented, and the remaining sherds are of jars.

One sherd has a pattern identical with that of Fig. 14, b, of Zuni sites 81 and 82 (C. Z. R.), broad line work, showing panels of triangular helices. Another sherd shows a design very similar to that of Fig. 13, e, of Zuni sites 86-96 (C. Z. R.). Four sherds of jars also show broad-line-hatched work.

Black Paint-on-Red. All sherds found are of bowls.

Black and White Paint-on-Red. All the sherds found of this type are of bowls. Both coarse and fine hatched work was used in the decoration. The other designs are similar to those previously described.

No. A K 4. (Plate E, Fig. 1, sherds 10-12 and Plate D, Fig. 2, sherds 2 and 3 and 12.) Twenty-one per cent red ware. This ruin is a suburb of ruin No. A and was included in my former report on that site.

Corrugated. The ware of this type comprises twenty per cent of

the total sherds collected. The only notation that the writer has concerning this ware, other than that its sherds are similar to those of ruin No. A K 3, is that one sherd had been rounded into a gaming disk.

Black-on-White (including the Shiny Painted Ware.) Sixty per cent of this ware is of jars; one dipper is also represented, and the rest are of bowls. One sherd has also been made into a gaming dice. Some hatched work was noted, but it is not a dominant type of design. One sherd is decorated in interlocking scrolls, much like the upper design of Fig. 78 and the design on the bowl of Fig 81 (Fewkes), only in reverse order, both of Fewkes' figures being from Kintiel. This interlocking decoration also reminds one of some of the patterns from the San Juan region. One sherd has a design with a strong "under-framework" effect like the Kayenta ware of Figs. 53 and 54 (K. & G.). Another design is of the diamond-shaped checkerboard type, each diamond of which has a single black dot for its center, also like those figured on Pl. 55, 21, 22, 24, 27, 23, and 10, but more like No. 22 and the "diamonds" of Plate 55, a, of Fewkes from Epley's Ruin, Gila Valley, Arizona. Another very similar design was also obtained. One sherd shows a saw-toothed design, like that of 55, 19, (K. & G.). Another design in duplication, is like the double toothed, notched, central figure of Fig. 12, f, from Zuni site 24 (C. Z. R.). The unpainted side of the sherd that had this design, as of many other sherds of this collection, was roughly finished, being much scratched in the smoothing. Another sherd has the hatched points of a design which is identical with the design on the mug of Pl. 3 (Pueblo Bonito). One sherd has the exact figure of Fig. 14, c, of Zuni site 71, inverted. One pattern is a crude design of a bird, another design closely resembles the white, checkerboard design of Pl. 37, b, from Chevelon, Arizona, (Fewkes).

Black-Paint-on-Red. Only bowls are represented by the sherds obtained. Of these, one sherd has a design exactly like that of Fig. 14, c, of Zuni site 71, also inverted.

The mention of a white-on-black sherd that was obtained with the above sherds should also be noted. It was a black painted potsherd, crudely painted in heavy bars in white.

No. A K 5. (Plate D, Fig. 2, sherds 2-7.) Eleven per cent red ware. This ruin is also a suburb of ruin No. A.

Corrugated. One-half of the sherds of this type bear plain, broad coils, some of which have been obliterated. One sherd has also had its coils erased and then reindicated by incised lines. All of the above pottery, consequently, reminds one of much of the slab-house pottery of Pl. 57, c-g, and Pl. 64, e, of Kidder and Guernsey. The remaining sherds bear narrow corrugations and are all indented and well made.

Black-on-White (including the Shiny Painted Ware). Some of the black paint has a washed-out brownish cast. No new types of decoration appears, except as noted below. Two patterns are like that of the right-view design of Fig. 15, b, of Zuni site 149 (C. Z. R.).

Black Paint-on-Red. All the sherds obtained are of bowls. One

sherd has a pattern like that of the right view of Fig. 15 b, of Zuni site 149 (C. Z. R.). It is also shiny painted piece, while most of the other designs of this ware are similar to those previously described; that is, they are not of the shiny painted variety. Two sherds have exaggerated, triangular, zigzag designs, one having a stepped-line effect, like those of Fig. 59, a, of Kayenta, exaggerated. The other is a saw-toothed design, much like that of Pl. 55, 19, (K. & G.), but also much exaggerated. Two other sherds have characteristic, checkerboard square-diamond-shaped designs in white.

No. 45. Sunrise Springs Tower Ruin.) (Plate D, Fig. 1, sherds 1-6, and Fig. 2, sherds 13-16.) Five per cent red ware.

Corrugated. Forty-six per cent of this ware has its coils frequently obliterated wholly or in part, often then re-indicated by incised lines. Other coils are broad or poorly made. Some plain vessels are also represented by sherds. The above sherds, in make, are all reminiscent of the slab-house type of pottery. The remaining sherds bear narrow corrugations, both indented and plain. A few sherds also show plain and indented coils on the same sherd.

Black-on-White (including 9 per cent Gray Ware with slip and 2 per cent Shiny Ware). Eleven per cent of this ware is of the hatched type, resembling the hatched ware of Pueblo Bonito, also something like the same ware of Kayenta and Zuni. Several sherds carry dotted triangles. One sherd has the characteristic Zuni step design of Fig. 15, b, and e, of site 149 (C. Z. R.). The other designs do not differ much from those previously described.

Black Paint-on-Red, and Black and White Paint-on-Red. The sherds of these types are too few for characterization, except that a sherd of the latter group has a design on the inside like that of Fig. 14, i, of Zuni site 71 (C. Z. R.). One sherd is also daubed much with white paint without.

Note. This ruin has a small per cent of shiny painted ware and is consequently doubtfully placed in this list, because of so much of its other pottery being of earlier type.

No. A-3. (Plate D, Fig. 2, sherds 8-11.) Fifteen per cent red ware. Corrugated. This ware is mostly of wide mouthed jars and pots. These vessels were entirely corrugated, except for a short distance at the rim. The coils are all characteristically narrow and indented, with the exception of those on one jar bottom and a few, apparently rubbed pieces. One black, corrugated piece was found in the collection, the other sherds are all light colored ware. On the whole, the ware resembles that of Zuni site 71 (C. Z. R.).

Black-on-White (including the Shiny Painted Ware of that color). Two dippers are represented in the collection. Two-thirds of the remainder are pieces of jars; the rest, fragments of bowls.

More than a fifth of the decorations of this ware is of the shiny paint type. The decorations are also very similar to those previously described. One design is practically exactly like that of Fig. 14, c, of Zuni site 71 (C. Z. R.),and five other designs are very similar to it. Two sherds are decorated with the double lightning design, separated

by a straight line. Several patterns resemble that of Fig. 14, i, of Zuni site 71 (C. Z. R.). Two also resemble the left hand lower design of the left hand figure of Fig. 14, j, of the same site. Most of the other designs are of the broad, mostly parallel line type. Hatched work occurs only on a few sherds. Three sherds also show a re-painting in white in a crude, daubing manner. One sherd also is of a shiny, dark brownish color, over shiny gray, on the inside, and is daubed over with broad, white lines on the outside.

Black Paint-on-Red (including the Shiny Painted Ware of that type). Ninety per cent of the vessels thus decorated are bowls. One dipper is also represented in the collection. The remaining sherds are of jars. Two-thirds of the ware is plain red on both sides. Two designs show coarse hatched work. The rest of the designs are broad straight lines, except a design on a sherd that somewhat resembles the step design of Fig. 14, c, of Zuni site 71, (C. Z. R.). Two designs also somewhat resemble the design of Fig. 14, i, of the same site.

Black and White-on-Red (including the Shiny Painted Ware of this type). All the sherds obtained were of bowls. The white paint is the smeared-over type like that previously described. One design is nearly like the step figures of Fig. 14, c, above. Another design on a cream colored sherd (a fragment of a ceremonial bowl) looks like a fancy G. Another barred design resembles an hour-glass in shape. The other patterns are mostly of the broad, straight line type.

No. A-4. Thirteen and a half per cent red ware.

Corrugated. All the fragments obtained are parts of jars of large size. Ten per cent of the pieces are of the flaring lip part of the vessels and are un-corrugated. Fifty per cent of the sherds bear plain, broad, or coarsely indented coils (some even having had the coils flattened or rubbed off), reminiscent of the slab-house tvpe. The remaining sherds bear narrow corrugations, all but one of which have indented coils. This coiled ware much resembles Spier's corrugated ware of Zuni site 24 (C. Z. R., p. 304).

Black-on-White (including the Shiny Painted Ware of those colors —the black being a brownish-black color). Bowls constitute one-half of the forms. Some of the decorations are cross-hatched work of a coarse type, though one sherd is mostly covered with fine hatched work. The double spiral form of decoration occurs on three of the sherds, being very similar to the spiral coils of Fig. 11, i, j, and k, of Zuni site 14 (C. Z. R.), and that of Pl. 54, j, (K. & G.), also a little resembling the coiled design of Pl. 22 from the San Juan Basin. One design resembles those of Fig. 13, l, and n, of Zuni site 146 (C. Z. R.) and the step-design on the right hand pitcher of Pl. 7 of Pueblo Bonito. Two designs are similar to the lightning designs of Pl. 55, 13, 14, 19, 20 and 23 of the Kayenta ruins (K. & G.) Another design is also of Kayenta pattern—opposite sets of isosceles triangles with their points touching, thus leaving diamond-shaped interspaces, each of which is occupied by a single dot like those of Pl. 55, 21-29 (above). One design represents a series of black bars from which rain drops are

falling. The design on several sherds is very imilar to that of Pl. 37, b, of Fewkes. The rest of the designs are of the heavy bar type.

Black Paint-on-Red. The sherds of this type are too few for a report.

Black and White Paint-on-Red. There is nothing new to report under this heading.

As a concluding remark, the writer wises to state that the pottery indicates that this village was a contempory with the village of site 24 of the Zuni ruins above.

No. 94. (at Steamboat). (Plate D, Fig. 1, sherds 7-13.) Five per cent red ware.

Corrugated. All the sherds obtained show coarse work, reminiscent of the slab-house type.

Black-on-White (including the Shiny Painted Ware of these colors). Only one shiny painted piece was obtained, its pattern closely resembling that of Fig. 13, k, of Zuni site 146. Of the other sherds, one carries a checkerboard design of buff on white. Two sherds carry diamond-shaped designs in white with black circular centers like the Kayenta designs of Pl. 55, 21-29 (above). Another sherd carries a similar design, but of larger size. A sherd also carries a pattern very similar to that of Fig. 15, e, of Zuni site 149 (C. Z. R.). One-fifth of the sherds carry hatched work designs. One sherd carries a double, continuous scroll, double coil design in duplicate. Another carries a heavy, notched pattern, also in duplicate, the sherd having been used as a smoothener. Another sherd also carries a notched pattern in white inclosed in black, which is itself inclosed in white bars.

Red Ware. The sherds of this ware obtained are all plain red.

No. 169. (Klagi-toh). (Plate D, Fig. 1, sherds 14-18). Twenty-six per cent red ware; six per cent buff ware; six per cent rough-dull-gray ware.

Corrugated. All of the sherds bear narrow, indented coils, except on the plain rim section.

Rough-Dull-Gray Ware. Sherds of this type are identical with those previously described, except they show the use of the slip and are not so coarsely made. They, too, appear to be of a later type of make.

Black-on-White (one sherd has black paint on green). Two-thirds of the sherds are jars and a few dippers. The black coloring is more or less brownish. Some of the painting is also more or less of the shiny paint nature, but not so pronounced as that previously described from other villages. Six sherds have very similar designs to the step designs of the Zuni sherds given as Fig. 14, c, and d, of site 71 and Fig. 15, b, e, and i, of site 149 (C. Z. R.), but more like that of "e" above. Five sherds have charrcteristic checkerboard designs in white and brown-black, somewhat resembling the checkerboard colored section of food bowl from Four Mile Ruin, figured as the upper figure of Pl. 61 of Fewkes. Another sherd has a cross-cut saw design very much like the cross-cut saw-toothed design on the bowl marked Pl. 50, b, from Shimapovi (Fewkes). The designs on

the other sherds are mostly composed of heavy lines and bars, generally of the parallel type. No hatched work was found at this ruin One design is also of the "under-framework" type, like that of some of the Kayenta ware.

Black and White Paint-on-Red (including the (6 per cent) buff ware). The designs are similar to those described under Black-on-White above, except that the cross-cut, saw-toothed design is lacking.

Note. The designs of this ruin, on the whole, show a mixture of ancient Hopi ware and of ancient Zuni ware. The predominating designs, however, are like those of Zuni site 149 (C. Z. R.), pp. 248 and 314).

Kintiel (or, Wide Ruin). (Plate D, Fig. 1, sherds 19 and 20.) Thirty per cent red ware.

Dr. Fewkes (8:125-134) in commenting on the pottery of this ruin, stated, "The pottery of this ruin belongs essentially to the Zuni type."

To add to Dr. Fewkes findings, if possible, and to ascertain where the ruin belongs in the Zuni series of ruins and to compare its pottery with that of the ruins at Cornfields and vicinity, the writer collected sherds from it August 5th. An analysis of the potsherds obtained here follows:

Corrugated. This coiled ware, on the whole, is exceptionally fine, though a small per cent of the sherds obtained showed coarse work. Practically all the sherds bear narrow, indented coils, except from the plain rim section.

Black-on-White (including the near Shiny Painted Ware). One-fourth of the vessels represented by sherds are bowls. Seven dippers are also represented by fragments of handles. Moreover, as noted by Fewkes, all the sherds are white ware decorated with figures in black, and with a white slip rubbed over coarser clay. In firing, since the contraction and expansion of this slip is not the same as the base on which it is laid, we often find a crinkled surface. Some of the designs used in the decoration are as follows: One sherd has a double spiral design a little like that on the bowl represented as Fig. 97 from Four Mile Ruin (Fewkes), Fig. 11, k, (C. Z. R.), and Fig. 56, d, (K. & G.). Another sherd has diamond designs with round, black centers, like those of Pl. 55, 16 and 23 (K. & G.). One pattern much resembles the Kayenta zigzag designs of Pl. 55, 20-30 (K. & G.) and the Zuni zigzag figures given on the sherd of Fig. 13, j, of Zuni site 146 (C. Z. R.). Eighteen sherds have designs like those of the Zuni sherds figured as Fig. 13, l, and n, of site 146, Fig. c, and d, of site 71, and Fig. 15, b, e, and i, of site 149 (C. Z. R.), or modifications of those step designs. One sherd has a design like that of the right part on the left figure of Fig. 15, j, of Zuni site 149 (C. Z. R.), and that on the left side of the left figure of Fig. 14, j, of Zuni site 71 (above). The design of three other sherds is exactly like the Zuni design of Fig. 14, i, of the last mentioned site. The double lightning-zigzag design, separated by a straight line, occurs on one sherd. Some hatched work in design occurs, as well as "heavy" line and bar

work. Several sherds are decorated in little squares very similar to those of Pl. 39, b, of Fewkes. One sherd has a design of heavy lines of the white-over-black on both sides and another with black-on-white on both sides.

Black-on-Red. The larger per cent of this ware is of bowls. Many of the decorations are indentical with those on the black-on-white ware above. Four sherds bear the identical design of Fig. 14, i, of Zuni site 71, and several have designs almost identical with the Zuni designs given on sherds as per Fig. 14, c, and d, of site 71, and Fig. 15, b, e, and i, of site 149 (C. Z. R.). One sherd has a design very similar to that of Fig. 13, j, of Zuni site 186 (C. Z. R.). It also resembles the Kayenta step-zigzag figures of Fig. 59, a, and c, (K. & G.). Another sherd has a design with "under-framework" effect like the Kayenta designs of Fig. 54, a, (K. & G.). Several of the sherds also have red designs over a lighter red.

Kinna Zinde. (Plate D, Fig. 1, sherds 21-25). Forty-three per cent red and buff ware.

Dr. Fewkes (8:134) has suggested that Kinna Zinde was a summer ranchero of Wide Ruin (Kintiel). To use his words: "Kinna Zinde was possibly only a summer home, peopled by farmers from Kintiel." but the pottery found does not bear out this conclusion. Thirty per cent of the sherds obtained are of three-colored, yellow-buff ware and nothing like such a per cent of such ware was found at Kintiel. Moreover, this buff ware has a very modern appearance. There are also drawings of birds and insects on the buff series, which is not so characteristic a feature of design at Kintiel, though hatched work shows as a part of the design used.

One black-on-white design is like the step-zigzag design of the left figure of Fig. 13, j, of Zuni site 146. One of the corrugated pieces shows partial erasure of the coils which were then reindicated by a cross-coiling and the insertion of deep grooves. The other two corrugated pieces obtained, show well made, narrow, indented coil work.

The pottery, on the whole, has the Zuni slant. Moreover, the buff ware has more the appearance of modern Zuni pottery than that of the prehistoric villages; but the scarcity of the pottery, only 23 sherds were obtained, has left any conclusion in doubt. However, the writer would judge that it is a little older than site 33 of the Zuni series. (C. Z. R., pp. 225 and 317).

TECHNOLOGY

Slab-house Type

Corrugated. The pottery of this type, as we have seen, is usually composed of medium sized jars with plain, globular body, or of rough cooking ware with necks encircled by heavy, coarse corrugations. The coils are frequently obliterated in part or entirely erased and then reindicated by incised lines; otherwise they are usually broad and plain. Some of the vessels also show very crude and careless workmanship.

The paste of these vessels is usually a dull gray, is coarse and granular, containing an admixture of tempering material, apparently of ground up rock. It also contains a large content of sand, while the clay seems to have been of a poor quality.

Rough-Dull-Gray Ware, Without Slip, and Black-on-White Ware. These two wares are here considered together, because the sherds of the first group may, in part, be parts of bottoms of the vessels of the last, the "slipping" only covering the part of the pot that was later painted—no whole vessels of either ware have been seen by the writer also because the paste of the two wares seems to be identical. The ware in both cases is dull, coarse, rather rough, and usually of a gray (gray-white) to dirty gray color.

The paste of this series has a high content of sand, while the clay is a poor quality, or not enough of it was used in comparison with the amount of sand used—a gray clay heavily tempered with sand.

The rough-dull-gray ware, without slip is undecorated. The black-on-white ware is decorated only on the inside. The slip is usually white to yellowish white and the pigment a slaty shade of black. The characteristic design is that of thin lines set wide apart as edging. The decorative units are usually pendant from the rim, the commonest units being the pendant triangle, secondary triangles, line bordering dots, hooks, y's, hooked spirals, double spirals, vertical lines to mark off panels of design, horizontal lines to mark off separate bands, and stepped elements.

The sherds of this type of ware are mostly bowls and ollas.

Other Types of Pottery

Corrugated. This pottery is much the same as that previously described under "Slab-house Type", except it is better made and has a better paste. The vessels of this type are also entirely covered with narrow, indented coils, except for a plain flaring rim.

The "reminiscent" slab-house corrugated ware is a class of ware grading from the slab-house type into the pure, advanced type above, its make and composition varying with the intermediate state of culture represented.

Black-on-White. The paste of the sherds of this type is of a fine, strong, grayish white color, the paste of some sherds also having a bluish to blackish-brown cast in the slip. Most of the ware of this type was also covered with a calcerous crustation, which can readily be removed by washing. The white, too, is a slip rubbed over coarser clay. In firing, since the contraction and expansion of this slip is not the same as that of the base on which it is laid, the surface is crackled.

Colored Ware. No study of the technique of this ware was made.

KINDS OF VESSELS

The kinds of vessels represented by the sherds of this region are as follows:

Corrugated. Pots (ollas), and carrying and storage vessels.

Other Ware. Cooking jars, cups, mugs, ladles, vases, slipper jars,

dippers, food bowls, ceremonial bowls, sprinklers used in the medicine ceremonies, globular bowls, collanders, jugs and canteens.

The results are summed up in the tables at the end of the article.

Concluding Remarks on the Archaeology of the Region

The evidence adduced from the analysis of the sherds is that some of the sites were re-occupied at different times. The majority of the sites, however, seem to have been occupied but once, some throughout the whole village period and others at different times within that period. The sherds, as we have seen, also divide themselves into groups, as follows: Corrugated, Gray Ware (rough-dull-gray ware, without slip), Black-on-White Ware, Two Color Painted Ware, Three Color Painted Ware. Two Color Shiny Painted Ware and Three Color Shiny Painted Ware. They seem to represent six "epochs" of Pueblo culture: Slab-house, Pit Dwelling, Black-on-White Pottery Series, Two Color Painted Ware Series, Three Color Painted Ware Series, and Shiny Painted Ware Series.

The slab-house type of ware corresponds to the Zuni slab-house ware of Spier, being practically identical in every detail (if he included his gray (unslipped) ware with his black-on-white ware of that series.) The pit dwelling ware seems to have no counterpart at Zuni, but is met with in the Pagosa-Piedra country in Colorado and the Upper San Francisco River section of New Mexico and Arizona. The black-on-white ware is the same as that at Zuni. The two color painted and the three color painted ware series also correspond to Spier's Zuni Painted Ware Series, both in percentages of color and in the patterns used in the decoration: the patterns figured from the Zuni sites of that period having been regularly used here especially those of sites 86, and 96, 81 and 82, 71, 146 and 149. The Shiny Painted Ware series has no counterpart at Zuni, it apparently being an intermediate stage between the Painted Ware Series Stage and that of the Glazed Ware Series there. However, the patterns used are like, or very similar to, those of Zuni sites 71, 146 and 149.

Ruin 64 (64L and 64M) and Kinna Zinde, in make-up of pottery, do not seem to belong exactly to any of the above groups, the latter evidently being a late site.

The development in the designs also seems to have been from the slab-house (and pit dwelling) stage through a small house stage to the pueblo type, the latter corresponding to the greatest expansion of the Zuni during the Painted Ware and Glazed Ware stages, as outlined by Spier. The character of the sherds also point to a "much moving about" with the changing of village sites and a coming and going of "foreign" peoples. The evidence also points to the abandoning of the country soon after the building of the pueblos.

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TABLE I.

POTTERY FRAGMENTS FROM THE CORNFIELDS—GANADO REGION, ARIZONA.

NUMBER OR NAME OF RUIN----------	Rough-dull-grey ware, without slip-----	All red------------	White, whitish, or grey on one side or two, except red, below-------	Black patterns on white (some blackish patterns)	Green patterns on white	Brown patterns on white	Red patterns on yellow	Black patterns on red	Red patterns on white	Red patterns on cream color----------	Red on one side or two (red on one side and white on the other has been counted red)----	Three colors, black and red on white-------	White patterns on red, usually only on one side	Three colors, black and white-on-red-------	Corrugated, black or dark----------	Corrugated, white or light-----------	TOTALS Rough-dull-grey ware, without slip------	Containing any red	White, or black-on-white ---------	Corrugated------	TOTAL--------
A	15	...	161	197	...	...	5	103	23	...	17	...	29	..	...	215	12	139	205	215	571
AB	20	4	49	...	..	...		15	1.	...	19	5	...	..	...	57	20	19	49	57	145
AK	...	...	75	75	1	...		36	...	...	10	..	2	...	...	35	...	36	75	35	146
AK2	...	...	44	24	...	...		10	...	...	10	1	9	...	...	20	...	19	54	20	95
AK3	...	...	...	31	...	...		4	...	...	14	...	10	...	...	12	...	14	31	12	57
AK4	...	...	40	40	...	...		15	...	...	15	...	8	...	...	14	...	15	45	14	72
AK5	12	4	30	30	...	...		12	...	1	16	...	2	...	...	34	12	16	35	34	95
A-1	30	...	...	62.	...	...		...	...	...	...	...	...	...	...	65	30	...	62	65	137
A-2	...	2	...	48	...	...		16	...	...	16	...	...	...	...	40	...	21	50	40	111
A-3	...	8	52	52	...	...		18	...	...	18	...	...	...	1	27	26	26	52	28	106
A-4	...	1	...	51	...	...		2	...	...	...	8	...	...	...	30	...	11	51	30	92
A-5	...	1	32	32	...	...		3	...	...	5	1	...	...	1	17	...	3	32	18	53
A-6	5	5	...	30	...	...		4	...	...	...	...	4	...	...	40	5	4	30	40	79
A-7	4	...	...	25	...	...		5	...	...	...	...	...	...	6	57	4	5	25	65	97
A-8	6	...	11	32	...	...		3	...	...	...	...	...	...	4	28	6	3	32	32	73
A-9	...	...	...	8	...	...		1	...	...	...	...	...	...	...	9	...	1	8	9	18
A-10	and RR	...	...	39	...	...		1	...	...	...	...	...	...	...	22	...	1	39	22	62
2L (first visit)	85	...	...	56.	...	...		...	...	...	...	...	...	...	...	...	85	...	56	...	141
2E (second visit)	13	...	...	11	...	...		...	...	...	...	...	...	...	...	1	13	...	11	1	25
2F	35	...	...	45	...	...		3	...	...	...	...	...	...	2	29	35	5	45	31	114
8	...	...	71	71	...	...		...	...	...	...	...	...	...	...	91	...	...	71	91	16
9	...	...	161	122	...	...		...	...	...	...	...	...	...	...	142	...	...	161	142	3[illegible]
103/4	...	1	...	22	...	...		...	...	...	...	...	...	...	...	39	...	1	29	39	
17	95	...	132	132	...	...		...	...	...	...	...	...	...	2	98	95	...	132	100	
17½	38	...	16	16	...	...		1	...	...	...	...	...	...	...	7	38	1	16	7	
333	...	...	44	44	...	...		3	South	section		...	...	...	...	6	...	3	44	6	

TABLE I---(Continued).

POTTERY FRAGMENTS FROM THE CORNFIELDS-GANADO REGION, ARIZONA

NUMBER OR NAME OF RUIN	TOTAL	Corrugated	White, or black-on white	Containing any red	Rough-dull-gray ware, without slip	TOTALS: Corrugated, white or light	Corrugated, black or dark	Three colors, black and white -on -red	White patterns on red, usually only on one side	Three colors, black and red -on-white	Red on one side or two (red on one side and white on the other has been counted as red)	Red patterns on cream color	Red patterns on white	Black patterns on red	Red patterns on yellow	Brown patterns on white	Green patterns on white	Black patterns on white (some blackish patterns)	White, whitish, or gray on one side or two, except red, below	All red	Rough-dull-gray ware, without slip
35N	64	8	51	5	....	8	....	....	....	....	....	....	....	5	....	....	....	51	51	....	....
34	19	2	17	....	....	2	....	....	....	....	....	....	....	....	....	....	....	17	17	....	....
35	27	8	25	2	....	2	....	....	....	....	....	....	....	2	....	....	....	25	25	....	....
45N	68	37	14	3	14	37	....	....	....	....	....	....	....	3	....	....	....	14	....	....	14
45	482	150	270	21	....	125	5	....	8	8	21	....	....	11	....	....	....	244	270	2	....
46	154	65	78	6	10	62-	3	....	....	....	....	....	....	....	....	....	(Second visit)	78	78	3	10
46	18	5	13	....	....	5	....	....	....	....	....	....	....	....	....	....	(First visit)	13	13	....	....
47A	78	12	....	....	66	....	....	....	....	....	....	....	....	....	....	....	(South ruin of the group)	12	12	....	66
47A2	40	2	....	....	38	....	....	....	....	....	....	....	....	....	....	....	(Next ruin N. of No. 47A)	2	....	....	38
47A3	200	10	....	....	190	....	....	....	....	....	....	....	....	....	....	....	(Next ruin N. of No. 47A2)	10	....	....	190
47A4	50	1	....	....	49	....	....	....	....	....	....	....	....	....	....	....	(The next ruin N. of No. 47A3)	1	....	....	49
47A5	4	3	....	....	1	3	....	....	....	....	....	....	....	....	....	....	(The north ruin of the group)	....	....	....	1
50	48	12	29	1	....	12	....	....	....	....	....	....	....	1	....	....	....	29	....	....	....
51	68	17	46	5	....	17	....	....	....	....	....	....	....	5	....	....	....	46	46	....	....
52	155	35	98	....	....	35	....	....	....	....	....	....	....	....	....	....	....	98	....	....	....
54	74	16	55	1	....	18	....	....	....	....	....	....	....	....	....	....	....	55	55	1	....
54A	166	39	121	6	....	39	....	....	....	....	....	....	....	....	....	....	....	121	....	6	....
55	11	3	8	....	....	3	....	....	....	....	....	....	....	....	....	....	....	8	....	....	....
56	22	6	16	....	....	6	....	....	....	....	....	....	....	....	....	....	....	16	....	....	....
64L	67	21	15	13	17	21	....	....	....	....	(Lower section of ruin)	....	....	13	....	....	....	16	....	....	17
64M	60	18	10	30	2	18	....	....	5	....	30	....	....	12	2	2	....	10	10	....	2
69 3/4	48	16	32	....	....	16	....	....	....	....	....	....	....	....	....	....	....	32	32	....	....
76	60	8	52	....	....	8	....	....	....	....	....	....	....	....	....	....	....	52	....	....	....
82	16	4	12	....	....	4	....	....	....	....	....	....	....	....	....	....	....	12	....	....	....
83	23	3	17	3	....	3	....	....	....	....	....	....	....	3	....	....	....	17	....	....	....
94	36	8	26	2	....	8	....	....	....	....	2	....	....	....	....	....	....	26	26	....	....
99	91	19	64	8	....	19	....	....	....	....	....	....	....	8 (two black on buff)	....	....	....	64	64	....	....

TABLE I---(Continued).

POTTERY FRAGMENTS FROM THE CORNFIELDS-GANADO REGION, ARIZONA.

NAME OR NUMBER OF RUIN	Rough-dull-gray ware, without slip	All red	White, whitish, or gray on one side or two, except red, below.	Black patterns on white (some blackish patterns)	Green patterns on white	Brown patterns on white	Red patterns on yellow	Black patterns on red	Red patterns on white	Red patterns on cream color	Red on one side or two (red on one side and white on the other has been counted as red)	Three colors, black and red-on-white	White patterns on red, usually only on one side	Three colors, black and white-on-red	Corrugated, black or gray	Corrugated, white or light	TOTALS: Rough-dull-gray ware, without slip	TOTALS: Containing any red	TOTALS: White, or black-on white	TOTALS: Corrugated	TOTAL
100	1			10			(first visit)				2				4		1	2	10	4	17
100	1			15				4					2		2		1	6	15	2	24
156				5				1	(first visit)						5			1	5	5	11
156				9		(Second visit)					1							1	9		10
157				57							3				3			3	57	3	63
158			52	52				4			5			1	14			10	52	14	76
159	19			1													19		1		20
160	11			21											2		11		21	2	34
161			56	56				2			4		2	2	15			4	56	15	75
162			45	45				2			5				13			5	45	13	63
163			1	1															1		1
164			29	29											5				29	5	34
165			26	26											23				26	23	49
166	7			1											1		7		1	1	9
167N-1	20			37											20		20		37	20	77
167N-2	40			107							1				45		40	1	107	45	193
168	32			72											42		32		72	42	146
169	11		56	56	(Klagito Ruin)						48		2	2	37		11	48	56	37	152
170	21		37	37											19		21		37	19	77
171			13	13											2				13	2	15
Kintiel	7		117	117				98					11	11	77		7	98	117	77	299
Kinna Zinde	7		3					3			(buff)			7	3		7	10	3	3	23
GA	2			239				23			23		7	3	51		2	23	239	54	316
GB				852				16										16	852		868#

A sherd may carry several different patterns.

TABLE 2.

POTSHERDS FROM KAYAKKIMA (ZUNI SITE 46) COMPARED WITH THOSE OF THE FOLLOWING CORNFIELDS-GANADO RUINS

	KAYAKKIMA	A	KINTIEL	45	99
BLACK-ON-WHITE					
Black or dark brown on white, outside white	4	86	51	63	28
Black or dark brown on white, outside red	2				
Black on white, outside corrugated.......		1			
Shiny green on white, outside red........	2				
Black or dark brown on white; inside white or gray....................	7	105	66	139	36
Green on white; inside white.............	1				
Green on white; outside gray.............		1			
Black on white; inside black on white....	1	3	1		
Black on white; inside red...............	1				
Black on white, hatched ware.............		47			
Black on white, shiny ware...............		16	?	6	
Dark brown on pale yellow; outside yellow	1				
Do. outside brown	1				
" inside pale yellow	2				
" " brown	1				
" " reddish	1				
" " gray......	1	1			
" " same colors	2				
Dark brown on yellow; inside same color...	1				
Black, glossy green, or dark brown on gray, light brown, or greenish gray inside.....	5				
The same with pattern outside...........	3				
Gray, both sides, with slip....................				27	
RED ON REDDISH					
Style of Yuma ware; pattern outside; inside same color.........................	2	5		3	
WHITE ON RED					
White on red; inside glossy black on red...	3	29	11	11	
Do. " maroon on white..........	1				
" " green on white...........	1				
Red on white; inside white................		1			
Red on white..............................	1				
Red on white; inside glossy black in red..		26			
BLACK ON RED					
Black on red; outside red.................	5	57	98	7	6
Black on salmon; outside salmon...........	3	5			2
Glossy dark green on red; outside red......	2				
Black on red; inside gray.................		3	1		
THREE COLORED					
Black and red or maroon on gray or buff or yellow; inside same ground color...........	5				
Black and red on white; inside red.........	1				
Do. buff " "	2				
" white black.......	1				
Dark brown and red on white; inside white..	1				
Dark brown and red on yellow; inside brown or white..........	1				
Glossy black, green, or brown and red or reddish brown on white; outside red, reddish or white......................................	3				
Black and white on red; outside red or white	1			11	
Four shades from pale yellow to dark red; outside polished gray..................	1				
Step-like, zigzag patterns...............		23		47	
CORRUGATED WARE..........................	#	215	77	130	19
TOTAL SHERDS	70	624	305	422	91

After Kroeber, A.L.; Zuni potsherds, above, p. 25.

TABLE 3.

POTSHERDS FROM MATTSAKYA (ZUNI SITE 48) compared with those of the Cornfields-Ganado Ruins.		A	AK	KINTIEL	45	99
1. Black, dull and gray, all without slip, mostly smoothed, black inside	307	15				
2. Grey, crackled, polished, texture different from white and yellow slip	12				27	
3. Red, polished, some on both sides, some with white slip on one side	13	17		98	93	6
4. White slip on one side	30	161		117	191	64
5. Yellowish slip---about half of the pieces on both sides, the other half usually have a polished grey, perhaps slip gray, on the outside	43			5		2
6. Corrugated, black	5				5	
7. Corrugated, white (light)-- some with a thin white slip, others with thick, gray, smooth slip (?) on inner side	10	215	35	77	125	19
8. Black -on-white, shiny ware	?	?	?	?	?	?
9. Black-on-white; only two show hatching. Pattern mostly on the inside and generally true black, but there are a few brown pieces	23	197	75	117	191	64
10. Black-on-white, hatched ware					45	
11. Brown-on-yellow:						
Pattern inside, outside white, yellow, or gray	17					
Pattern inside, outside red	2					
Pattern on both sides	5					
12. Brown or grayish, from very light to black	11					
13. Black-on-red; only one hatched; undecorated side either white or red	11	103	15	98	7	
14. Red-on-white		23				
15. Red-on-yellow	2	5				
16. White-on-red, usually only on one side		29	21	11	11	

TABLE 4.

PERCENTAGES OF POTTERY WARES PRESENT AT RUINS

SITE	Corrugated	Rough-dull gray, without slip	Two color painted ware			Three color painted ware			Two color shiny painted ware			Three color shiny painted ware			Size of sample
			White	Red	Buff	White	Red	Buff	White	Red	Buff	White	Red	Buff	
A	37	2●	27	14			9		8					3	571
AB	42	15	20	9			3		15						145
AK	24		34	10			14		17						146
AK2	22		47	10			9		10					1	93
AK3	21		30	7			17		25				2		57
AKA	20		40	10			11		19						72
AK5	40		34	19			2		5						83
A-1	41		59												157
A-2	40		48	2			10								106
A-3	27		50	14											106
A-4	32		54	10½			3		8½						92
A-5	35		60	5											55
A-6	51	5	38				6								79
A-7	65	4	25	6											97
A-8	65	5(1 b)	25	5											51
A-9	50		44				6								18
A-10(a EX)	35		64	1											62
2W	28	30	40	2											114
2E		60	40				(First visit)								141
2E	4	52	44				●Second visit								25
8	56		44												162
9	47		55												303
10 3/4	63		56	1											62
17	31	29	40												325
17½	17	61	21	1											62
33N	12		81	7											64
33S	12		83	5											53
34	15		85												19
35	7		90				3								28
45N	54	20	20	6		(Exposed debris east of ruin No.45)									68
45	31		64	3			2								422
46	18		72			(First visit)									18
46	40	6	50	2	2	(Second gathering of pottery)									159
47A		85 g.	15			(The S. member of the 47-group)									78
47A2		95 g.	5			(The next ruin N. of 47A)									40
47A3		95	5			(The next ruin N. of 47A2)									200

TABLE 4---(Continued).

SITE	Corrugated	Rough-dull gray, without slip	Two color painted ware			Three color painted ware			Two color shiny painted ware			Three color shiny painted ware			Size of sample
			White	Red	Buff	White	Red	Buff	WHITE	Red	Buff	White	Red	Buff	
47A4		90	2	(The next ruin north of No.47A 5)											50
47A5		75	25	(The north ruin of the 47-group)											4
50	28		70	2											42
51	25		69	6											68
52	35		65												135
53	24		72	2	2	brown									165
54	24		75	1											74
54A	23		74	3	A ruin on a sand ridge ¼ mile E.of No.54)										166
55	25		75												11
56	24		75	1											22
64L	31	25	26	6	13	(Part of v., below the cross-wash)									67
64M	30	3	17	25	15			8	2	(Main village)					60
69 3/4	33		67												48
76	24		76												60
82	24		76												16
83	14		72	14											23
94	22		71	5					2						56
99	21		71	6	2										91
100	23	5	71				1	(First visit)							17
100	19	1	77	2			1	(Second visit)							24
156			90	10											10
156	40		45	10				(Second visit)							11
157	4		92	4											63
158	20		74	4					1						71
159		95	5												20
160	5	35	60												34
161	20		74	2			2	(Saline Springs ruin)							75
162	20		72	8				(Saline Springs ruin)							65
163			100					(Saline Springs ruin)							1
164	15		85												34
165	46		54												49
166	10	80	10												9
167N-1	25	25	50												77
167N-2	23	20	57												193
168	28	21	51												146
169	24	6	38	25	6		1	(Klagito ruin)							1152
170	24	27	49												77
171	13		87												15
Kintiel	26		40	30			4	x	x						292
Kinna Zinde	13	31	13	13				30	x#						23
GA	16		75	4	1		2	(A general collection)							316
GB	7		98	2	(A general collection collected by the school children)										868

#x, some sherds of this type are represented.

TABLE V.

PERCENTAGE OF POTTERY WARES PRESENT AT RUINS ACCORDING TO ASCENDING PERCENTAGE OF CORRUGATED WARE

SITE	Corrugated	Rough-dull gray ware without slip	Two color painted ware and shiny painted ware			Three color painted ware and shiny painted ware			Size of sample
			White	Red	Buff	White	Red	Buff	
163	0	.....	100	.....	.....	.....	.....	.....	1
9B	?	.....	98	2	.....	.....	.....	.....	868
2B	0	60	40	.....	.....	.....	.....	.....	141
47A	0	85	15	.....	.....	.....	.....	.....	78
47A2	0	95	5	.....	.....	.....	.....	.....	40
47A3	0	95	5	.....	.....	.....	.....	.....	200
47A4	0	98	2	.....	.....	.....	.....	.....	50
159	0	95	5	.....	.....	.....	.....	.....	20
156	0	.....	90	10	.....	.....	.....	.....	10
2B	0	52	48	.....	(Second	visit)	.....	.....	25
157	4	.....	92	4	.....	.....	.....	.....	65
160	5	35	60	.....	.....	.....	.....	.....	34
35	7	.....	90	.....	.....	.....	.....	3	28
166	10	80	10	.....	.....	.....	.....	.....	9
33N	12	.....	81	7	.....	.....	.....	.....	64
333	12	.....	83	5	.....	.....	.....	.....	53
Kinna Zinde	13	31	13	13	.....	.....	.....	30	23
171	13	.....	87	.....	.....	.....	.....	.....	15
83	14	.....	72	14	.....	.....	.....	.....	23
34	15	.....	85	.....	.....	.....	.....	.....	19
164	15	.....	85	.....	.....	.....	.....	.....	34
174	17	61	21	1	.....	.....	.....	.....	62
9A	18	.....	75	4	1	.....	2	.....	316
46	28	.....	72	(First	visit)	.....	.....	.....	18
100	19	1	77	2	(Second	visit)	.....	.....	24
158	20	.....	74	5	.....	.....	.....	1	71
161	20	.....	74	4	.....	.....	2	.....	75
162	20	.....	72	8	.....	.....	.....	.....	63
AK4	20	.....	59	10	.....	.....	11	.....	72
99	21	.....	71	6	1	1	.....	.....	91
AK3	21	.....	55	7	.....	.....	17	.....	57
AK2	22	.....	57	10	.....	2	9	.....	93
94	22	.....	73	5	.....	.....	.....	.....	36
54A	23	.....	74	3	.....	.....	.....	.....	166
100	23	5	71	(First	visit)	.....	1	.....	17
167N-2	23	20	57	.....	.....	.....	.....	.....	195
AK	24	.....	51	10	.....	.....	14	1	146
170	24	27	49	.....	.....	.....	.....	.....	77
169	24	6	58	25	6	.....	1	.....	1152
64	24	.....	75	1	.....	.....	.....	.....	74
53	24	.....	72	2	2 (brown)		.....	.....	163
56	24	.....	75	1	.....	.....	.....	.....	22
76	24	.....	75	.....	.....	.....	.....	.....	60
82	24	.....	76	.....	.....	.....	.....	.....	16
61	25	.....	69	6	.....	.....	.....	.....	68
66	26	.....	75	.....	.....	.....	.....	.....	11

TABLE 5---(Continued)

SITE	Corrugated	Rough-dull gray ware without slip	Two colorpainted ware and shiny painted ware			Three color painted ware and shiny painted ware			Size of sample
			White	Red	Buff	White	Red	Buff	
167N-1	25	25	50	......	....	......	......	......	77
Kintiel	27	....	40	30	....	......	4	x	292
A-3	27	....	58	14	....	......	1	.....	106
A-W	28	30	40	2	....	......	......	.....	114
50	28	....	70	2	....	......	......	.....	42
168	28	21	61	......	....	......	......	.....	146
64M	30	3	17	25	15	......	8	2	60
17	31	29	40	......	....	......	......	.....	325
45	31	....	64	3	....	x	2	.....	422
64L	31	25	25	6	13	......	.....	x	67
A-4	32	....	54½	10½	....	.....	3	.....	92
69 3/4	33	....	67	......	....	......	......	.....	48
A-5	35	....	60	5	....	......	......	.....	53
A-10 & RX	35	....	64	1	....	......	......	.....	62
52	35	....	65	......	....	......	......	.....	135
A	37	2	35	14	....	......	9	3	571
AK5	40	....	39	19	....	......	2	.....	83
A-2	40	....	48	2	....	.....	10	.....	106
46	40	6	50	2	2(	Second	visit)	....	159
A-1	41	....	69	......	....	......	......	.....	157
AE	42	13	33	9	....	......	3	.....	145
156	45	....	45	10	....	......	......	.....	11
165	46	....	54	.....	....	......	......	.....	49
9	47	....	53	.....	....	......	......	.....	303
A-9	50	....	44	.....	....	......	6	.....	18
A-6	51	5	38	.....	....	......	6	.....	79
45N	54	20	20	6	....	......	......	.....	68
8	56	....	44	.....	....	......	......	.....	162
10 3/4	63	....	36	1	....	......	......	.....	62
A-7	65	4	25	6	....	......	......	.....	97
A-8	66	5	25	5	....	......	......	.....	51
47A5	75	25	......	......	....	......	......	.....	4

TABLE 6.

SLAB-HOUSE SITES ARRANGED, ACCORDING TO ASCENDING PERCENTAGE OF GRAY (RANKING) WARE.

SITE	Corrugated	Gray	White	Size of sample
167N-2	23	20	57	193
168	28	21	51	146
167N-1	25	25	50	77
47A5	75	25		4
170	24	27	49	77
17	31	29	40	325
2W	28	30	40, plus 2 red	114
160	5	35	60	34
2E	4	52 (First	44 (visit)	25
2E (Second visit)		60	40	141
17½	17	61	21, plus 1 red	62
47A		85	15	78
47A2		95	5	40
47A3		95	5	200
159		95	5	20
47A4		98	2	50

TABLE 7.

PIT DWELLING TYPE.

SITE	Corrugated	Gray	White	Size of sample
164	15		85	34
165	46		54	49

TABLE 8.

BLACK-ON-WHITE SERIES.

SITE	Corrugated	Gray	White	Size of sample
163	0		100	1
166	10	80	10	9
171	13		87	15
34	15		85	19
76	24		76	60
82	24		76	16
55	25		75	11
46	38		62	18
69 3/4	33		67	48
52	35		65	133
9	47		53	303
8	56		44	162

TABLE 9.

TWO-PAINTED WARE SERIES, ACCORDING TO ASCENDING PERCENTAGE OF RED (AND BUFF) WARE.

SITE	Red	White	Gray	Corrugated	Size of sample
10 3/4	1	36		63	62
A-10 & RX	1	64		35	62
54	1	75		24	74
56	1	75		24	22
50	2	70		28	42
54A	3	74		23	166
46 (Second visit)	4(2 buff)	50	6	40	159
53	4(2 brown)	72		24	165
157	4	92		4	63
A-8	5	25	5	65	51
A-5	5	60		35	55
33S	5	83		12	65
45E	6	20	20	54	68
A-7	6	25	4	65	97
61	6	69		25	68
33N	7	81		12	54
99	8(2 bu.)	71		21	91
162	8	72		20	65
156	10	45 (Second visit)		45	11
156	10	90 (First visit)			10
83	14	72		14	23

TABLE 10.

THREE COLOR PAINTED WARE SERIES, ACCORDING TO ASCENDING PERCENTAGES OF RED (AND BUFF) WARE.

SITE	Two color and Three color		Three color		White	Gray	Corru- gated	Size of sample
	Red	Buff	Red	Buff				
100	1 (First visit)		1		71	5	23	17
35	3		3		90		7	28
100	3		1		77	1	19	24
161	4		2		74		20	75
158	6		1		74		20	71
A-6	6		6		38	5	51	79
A-9	6		6		44		50	18
A-2	12		10		48		40	106
64L	13	x	x		25	25	31	67
64M	25#	25	x	10	17	3	30	60

\# This column represents the "two and three colors" of this type, combined.

x. Shards of this type of color are also found in the collection.

TABLE 11.

SHINY PAINTED WARE SERIES, ACCORDING TO DESCENDING PERCENTAGE OF CORRUGATED WARE.

SITE	Corrugated	Two color painted ware			Three color painted ware			Two color shiny painted ware			Three color shiny painted ware			Gray	Size of sample
		White	Red	Buff	White	Red	Buff	White	Red	Buff	White	Red	Buff		
AE	42	20	9	....	....	3	....	13	....	....	....	....	....	13	145
AK5	40	34	19	....	....	2	....	5	....	....	....	....	....	....	83
A	37	27	14	....	....	9	....	8	....	....	....	....	3	2	571
A-4	32	54	10½	....	....	3	....	½	....	....	....	....	....	....	92
45	31	64	3	....	....	2		x	....	....	....	....	....	....	422
A-3	27	50	14	....	....	....	....	8	....	....	....	1	....	....	106
Kintiel	26	40	30	....	....	4	x	x	....	....	....	....	....	....	292
AK	24	34	10	....	....	14	....	17	....	....	....	....	1	....	148
169 (Kiagitoh)	24	33	25	6	....	1	....	x	....	....	....	....	....	6	1152
AK2	22	47	10	....	....	9	....	10	....	....	....	2	....	....	93
94	22	71	5	....	....	2	....	x	....	....	....	....	....	....	36
AK3	21	30	7	....	....	17	....	25	....	....	....	....	....	....	57
AK4	20	40	10	....	....	11	....	19	....	....	....	....	....	....	72
Kinna Zinde	13	13	....	....	....	13	30	x	....	....	....	....	....	31	23

x. A few sherds of these types were also found in the collection.

TABLE 12.

SHINY PAINTED WARE SERIES BY GROUND COLORS

SITE	Corrugated	Gray	White	Red	Buff	Size of sample
AE	42	13	33	12		145
AK5	40		39	21		83
A	37	2	35	25	3	671
A-4	32		54½	13½		93
45	31		64	5		432
A-3	27		58	15		108
Kintiel	26		40	34		[illegible]
AK	24	6	51	24	1	146
169 (Klagitoh)	24		38	26	6	[illegible]
AK2	22		57	21		[illegible]
94	22		73	5		[illegible]
AK3	21		65	24		[illegible]
AK4	20		59	21		[illegible]
Kinna Zinde	13	31	13	15	30	[illegible]